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Lössov et al.

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(54) **AUTOMATED PARCEL TERMINAL**

(71) Applicant: **Cleveron AS**, Viljandi (EE)

(72) Inventors: **Remi Lössov**, Viljandi (EE); **Anu Koppel**, Viljandi (EE); **Ott Pabut**, Tallinn (EE); **Rein Saetalu**, Viljandimaa (EE); **Arno Kütt**, Viljandimaa County (EE); **Mihkel Ilp**, Tartumaa (EE)

(73) Assignee: **Cleveron AS**, Viljandi (EE)

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G06Q 10/0836 (2023.01)
G07F 11/42 (2006.01)

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CPC ***G07F 11/16*** (2013.01); ***G06Q 10/0836*** (2013.01); ***G07F 11/42*** (2013.01)

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CPC A47G 29/1201; A47G 2029/149; G07F 11/16; G07F 11/42; G07F 11/10; G07F 11/1657; G07F 17/12; G07F 17/13; G06Q 10/0836; G06Q 20/18; B65G 1/04; B65G 1/137; B65G 1/1373; B65G 2201/0285; B65G 2203/0208; B65G 2203/04; E05G 1/06
USPC 232/24–26
See application file for complete search history.

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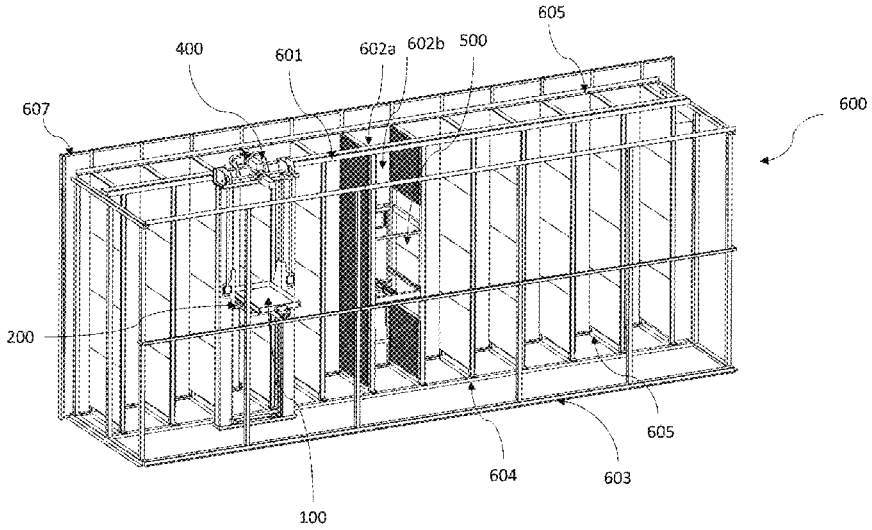
Primary Examiner — William L Miller
(74) *Attorney, Agent, or Firm* — Meunier Carlin & Curfman LLC

(57) **ABSTRACT**

An economic self-service terminal with simple but high safety features is described here.

9 Claims, 17 Drawing Sheets



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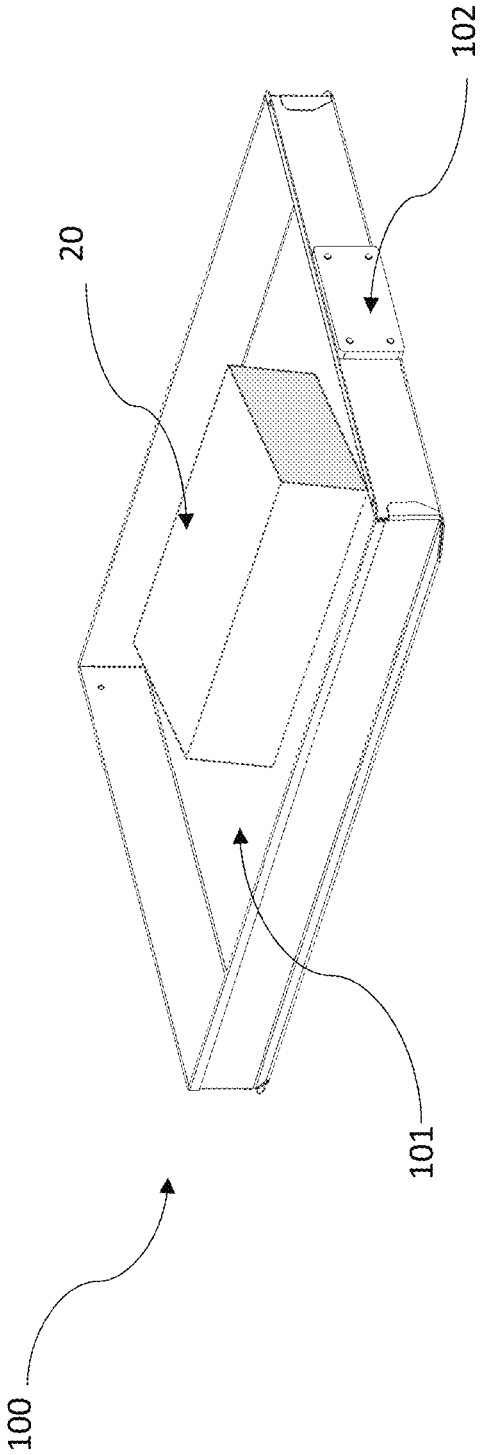
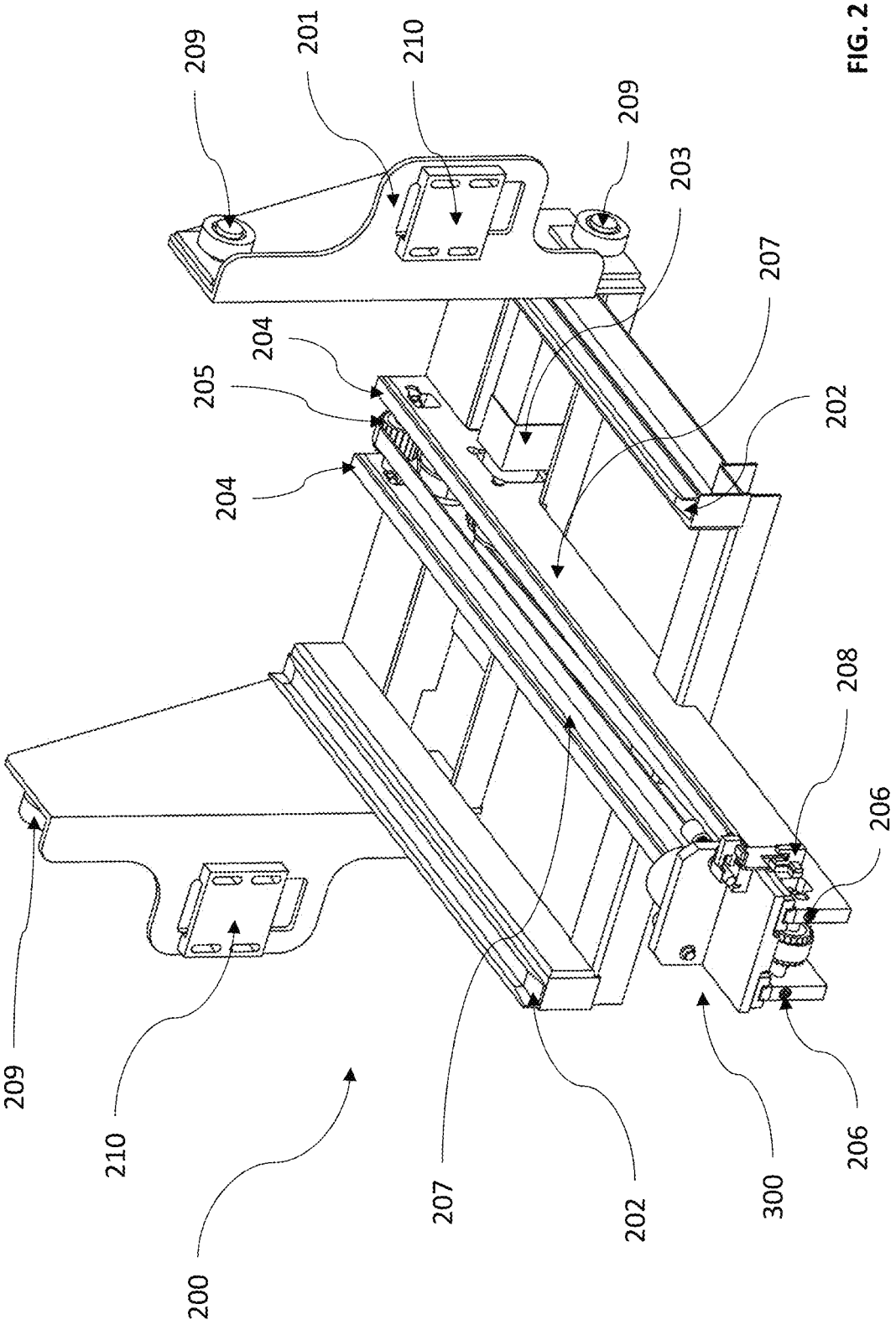


FIG. 1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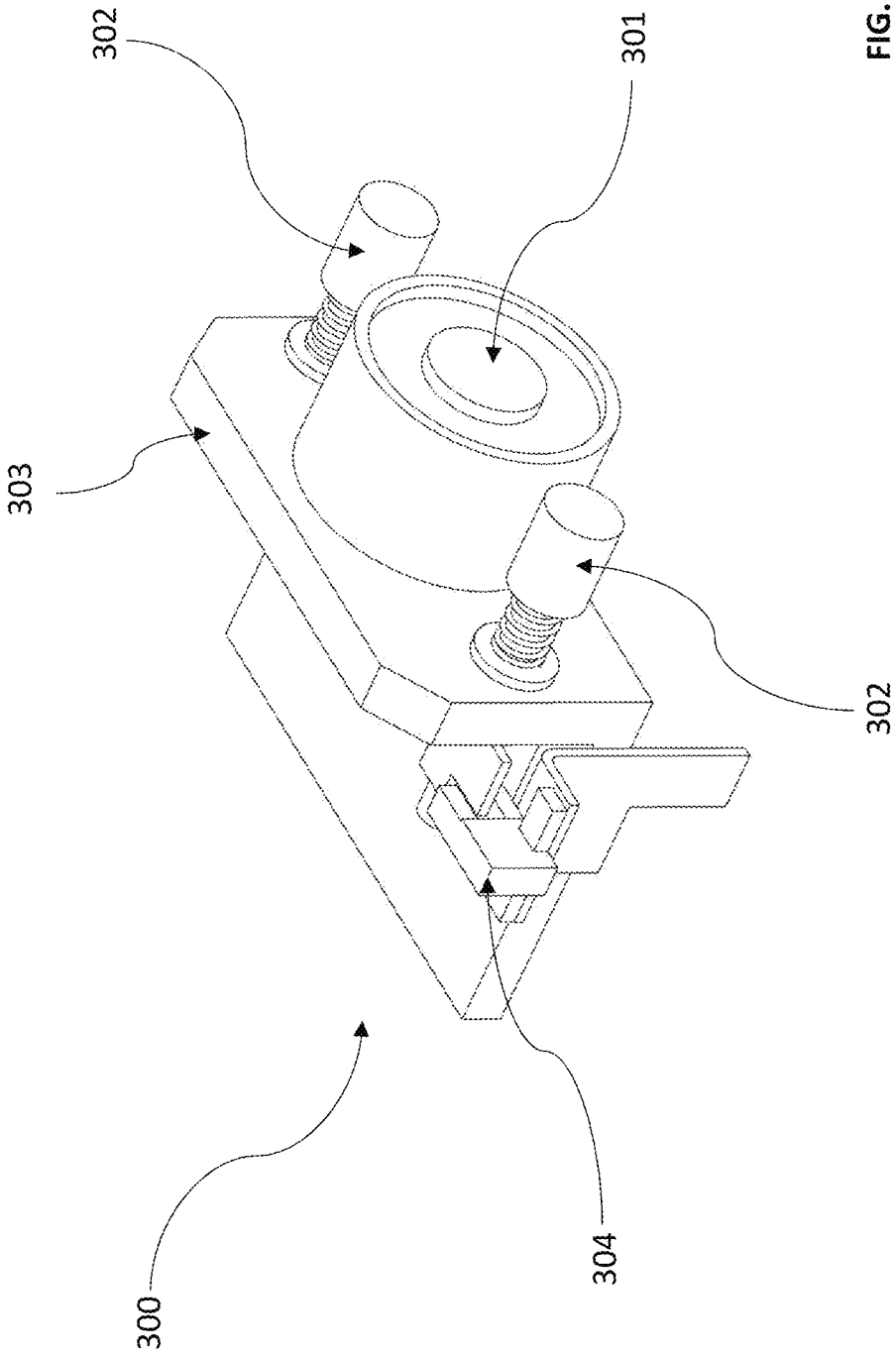

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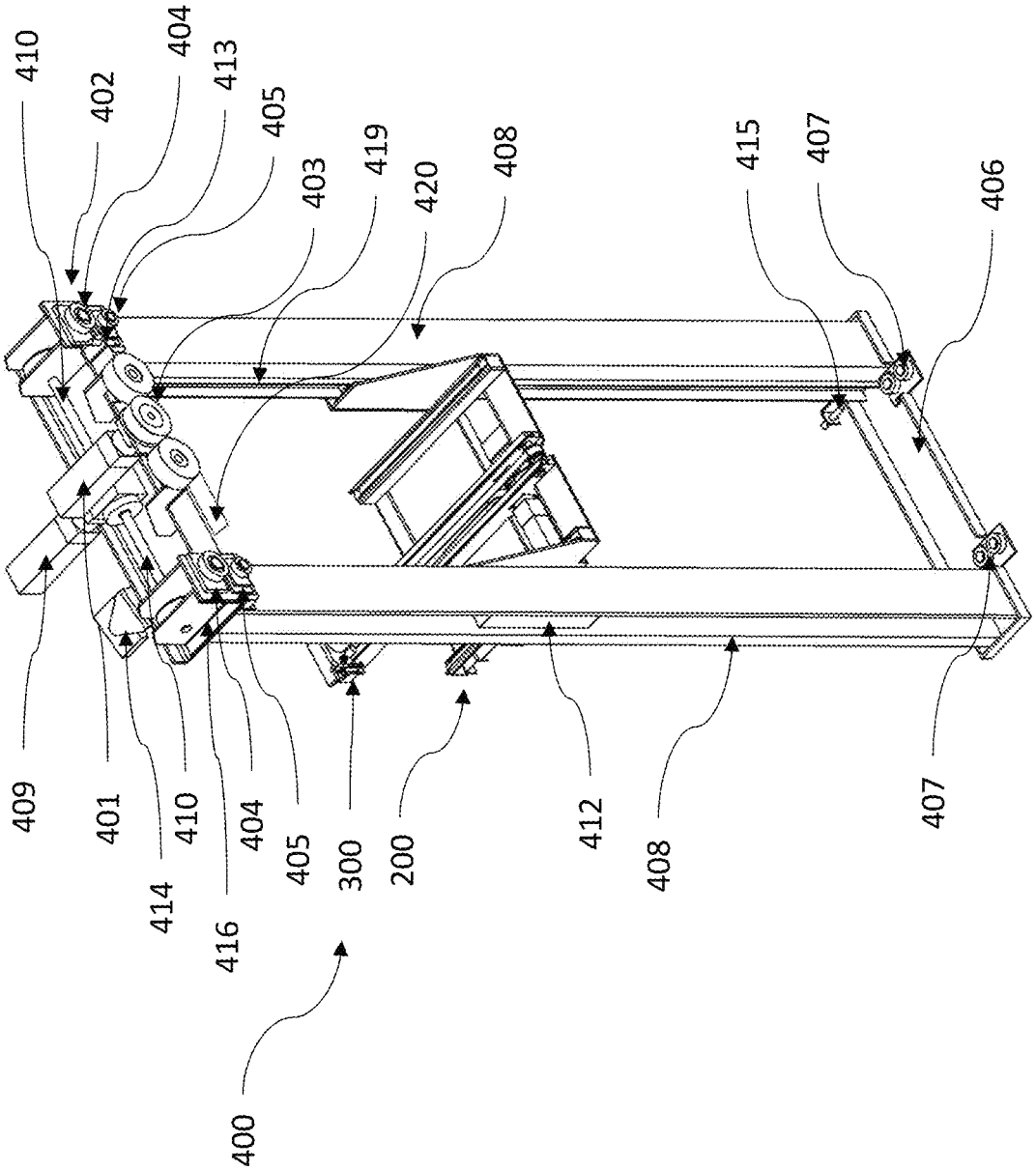
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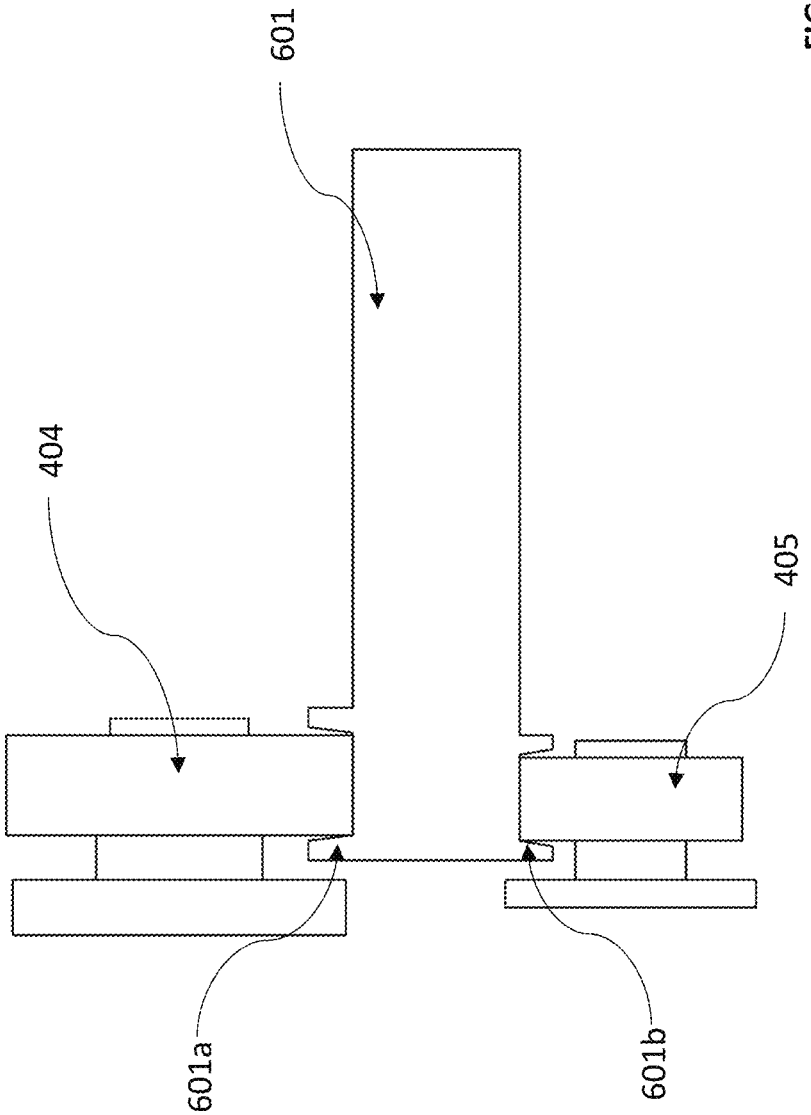
FIG. 4



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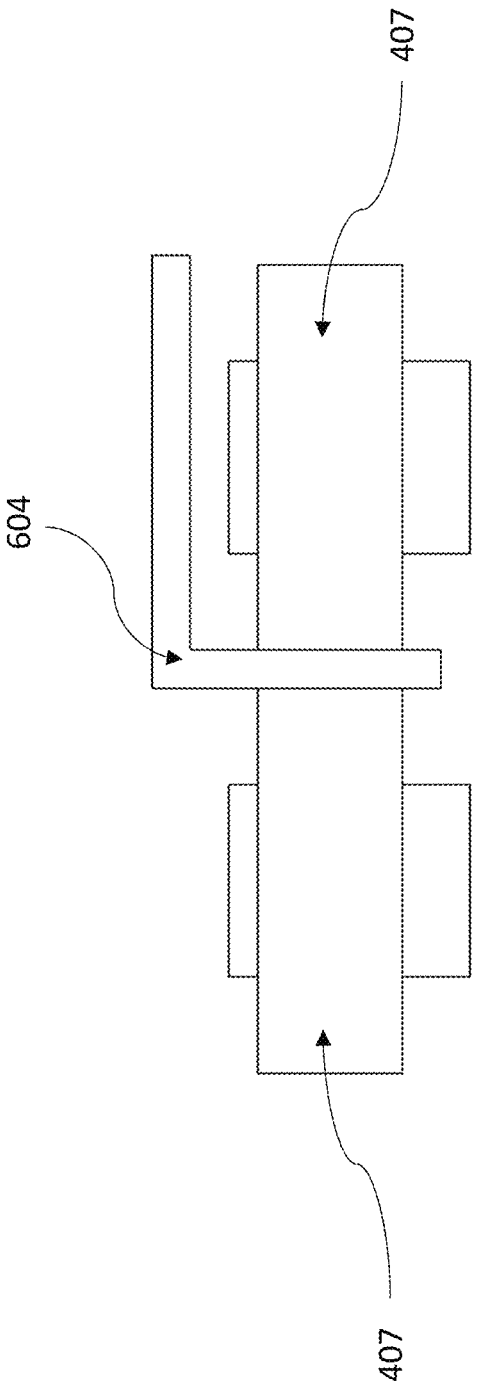

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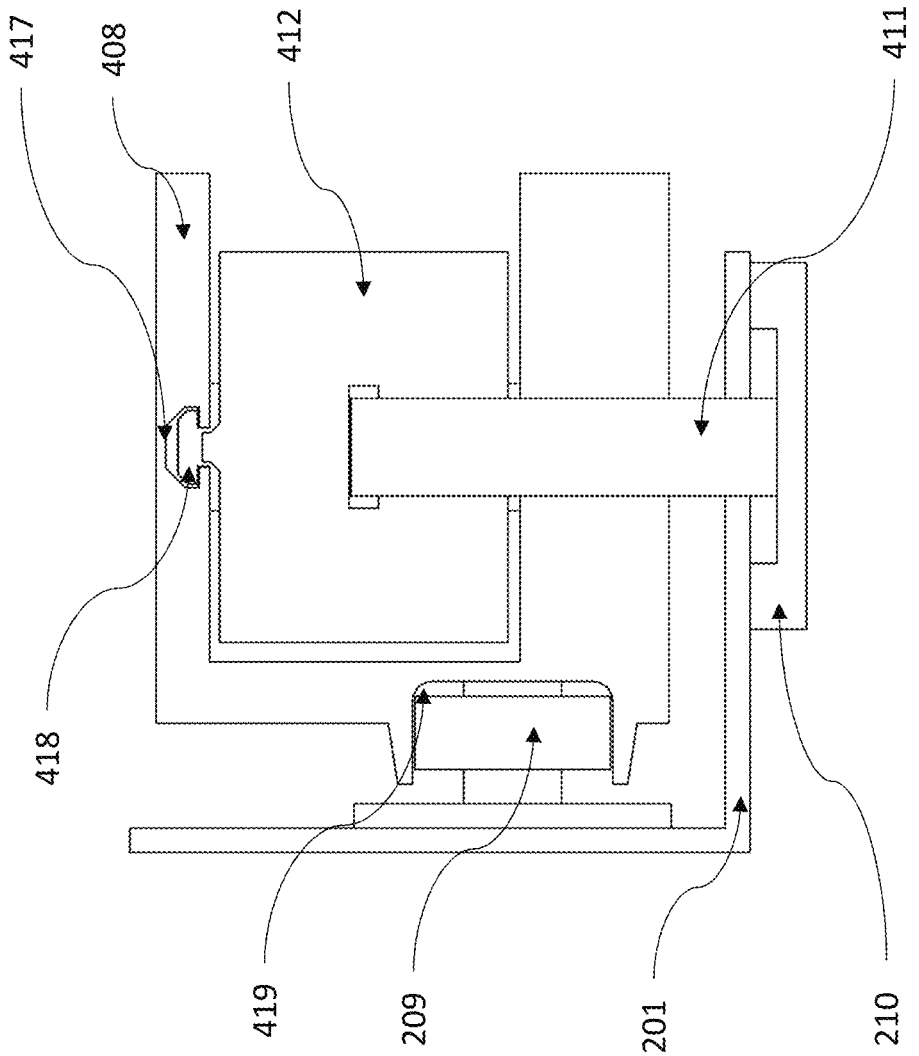

FIG. 7

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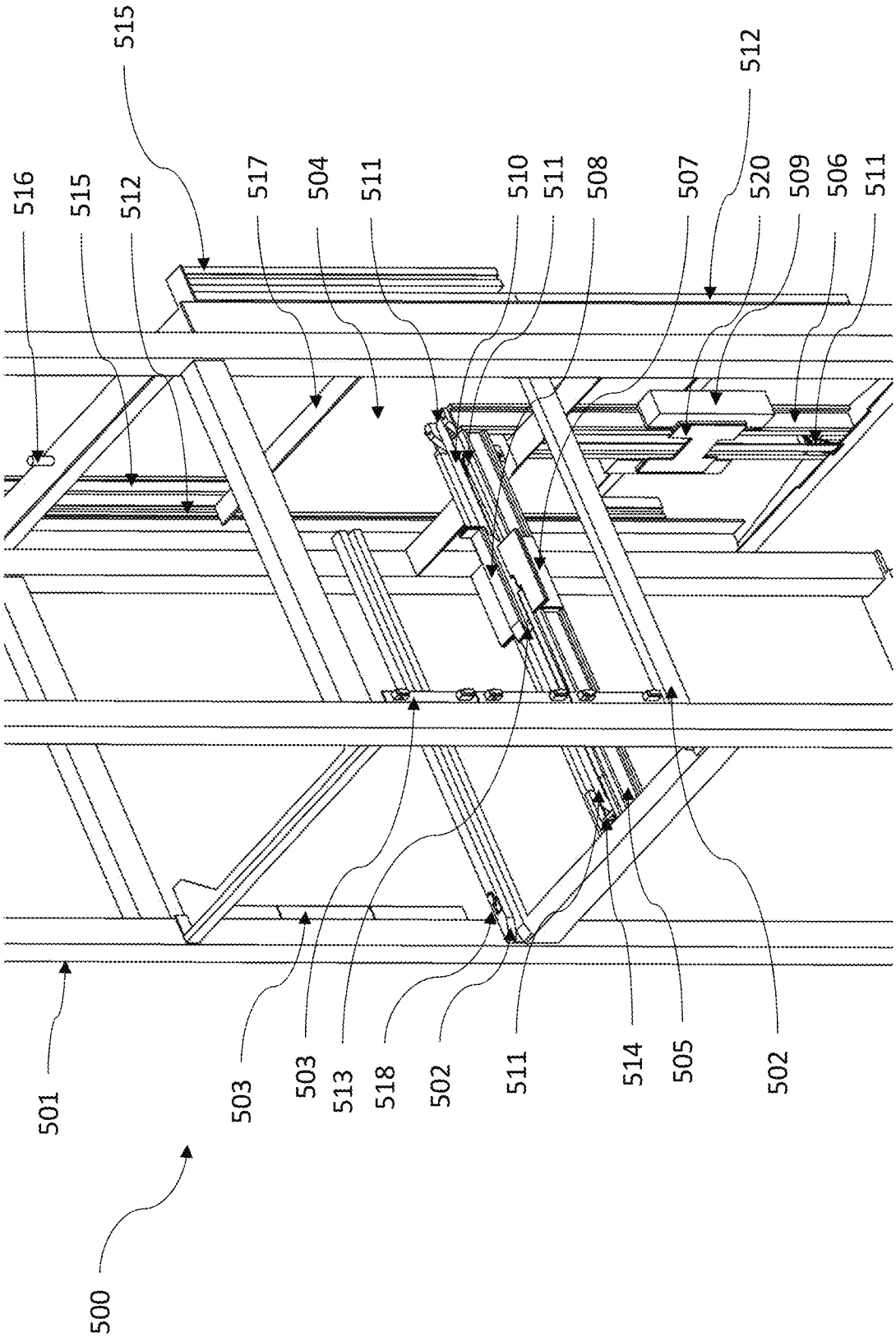
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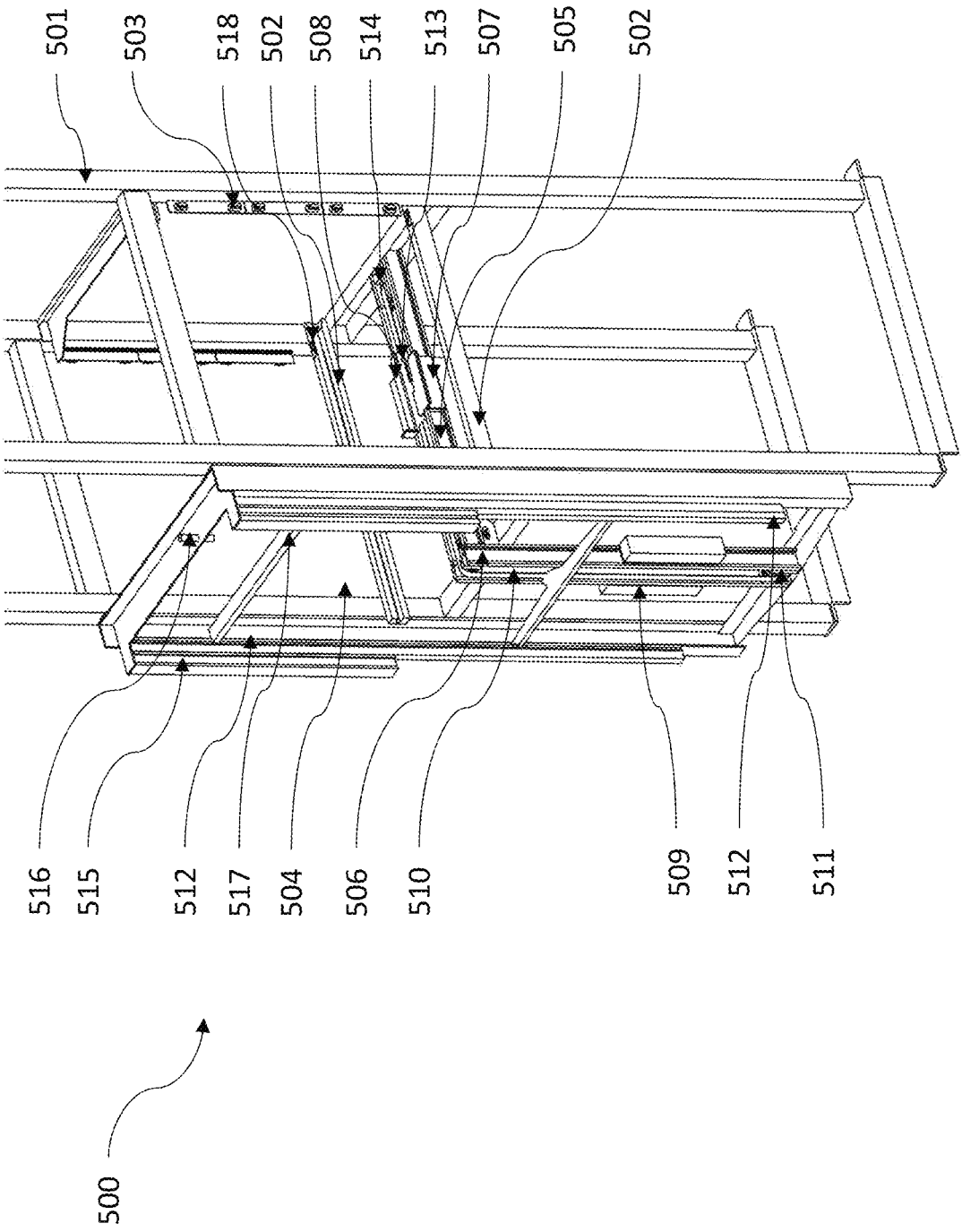
FIG. 9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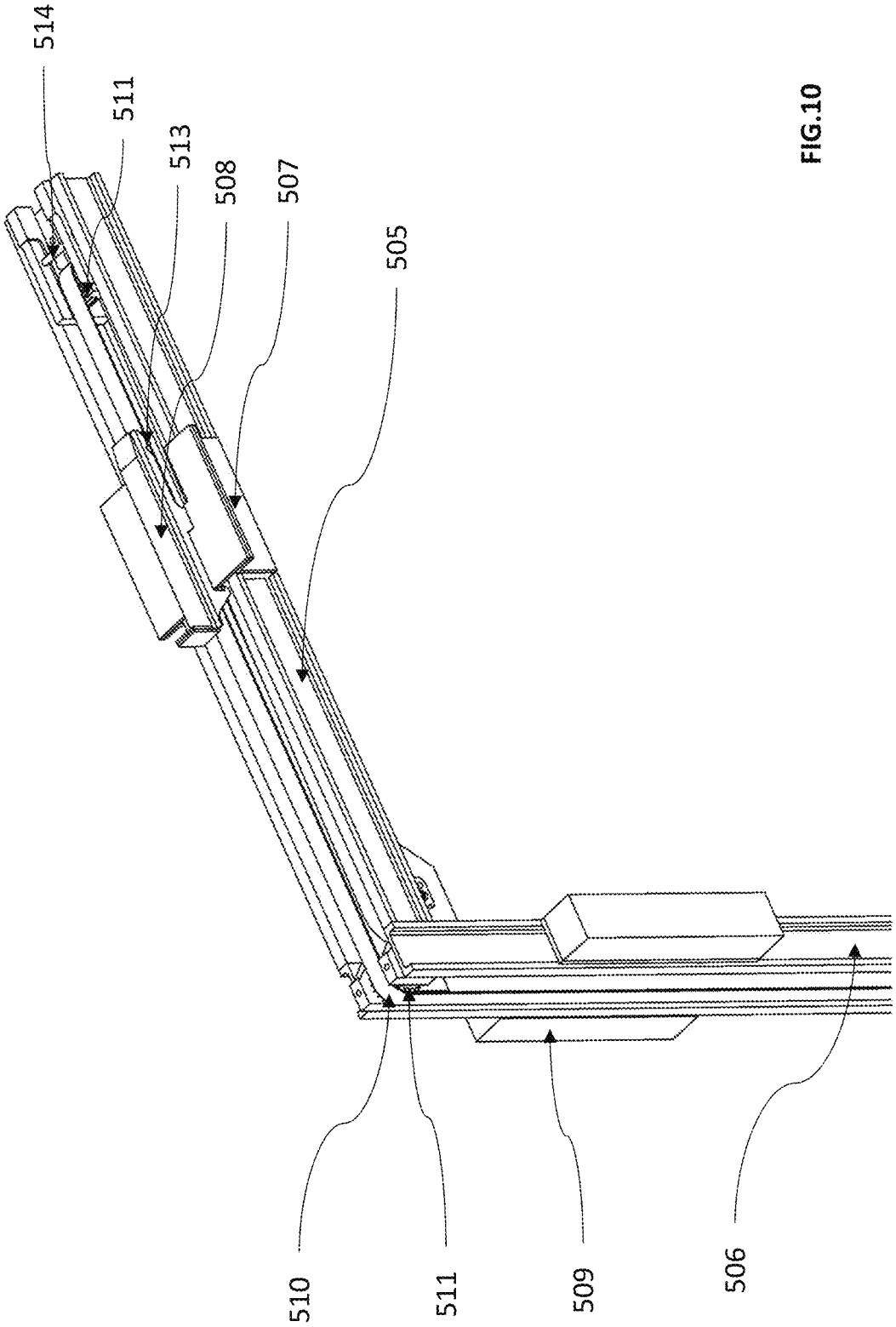
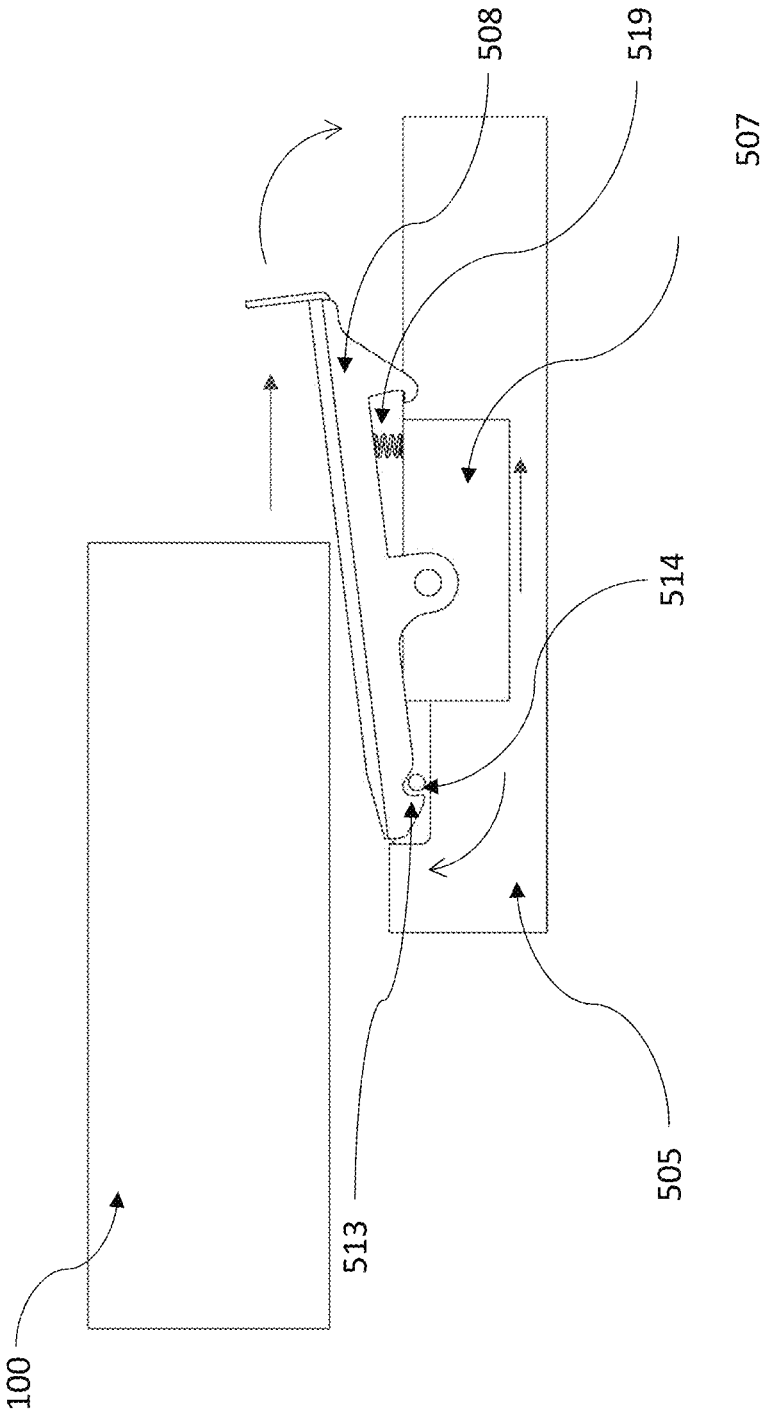


FIG.10

FIG.11



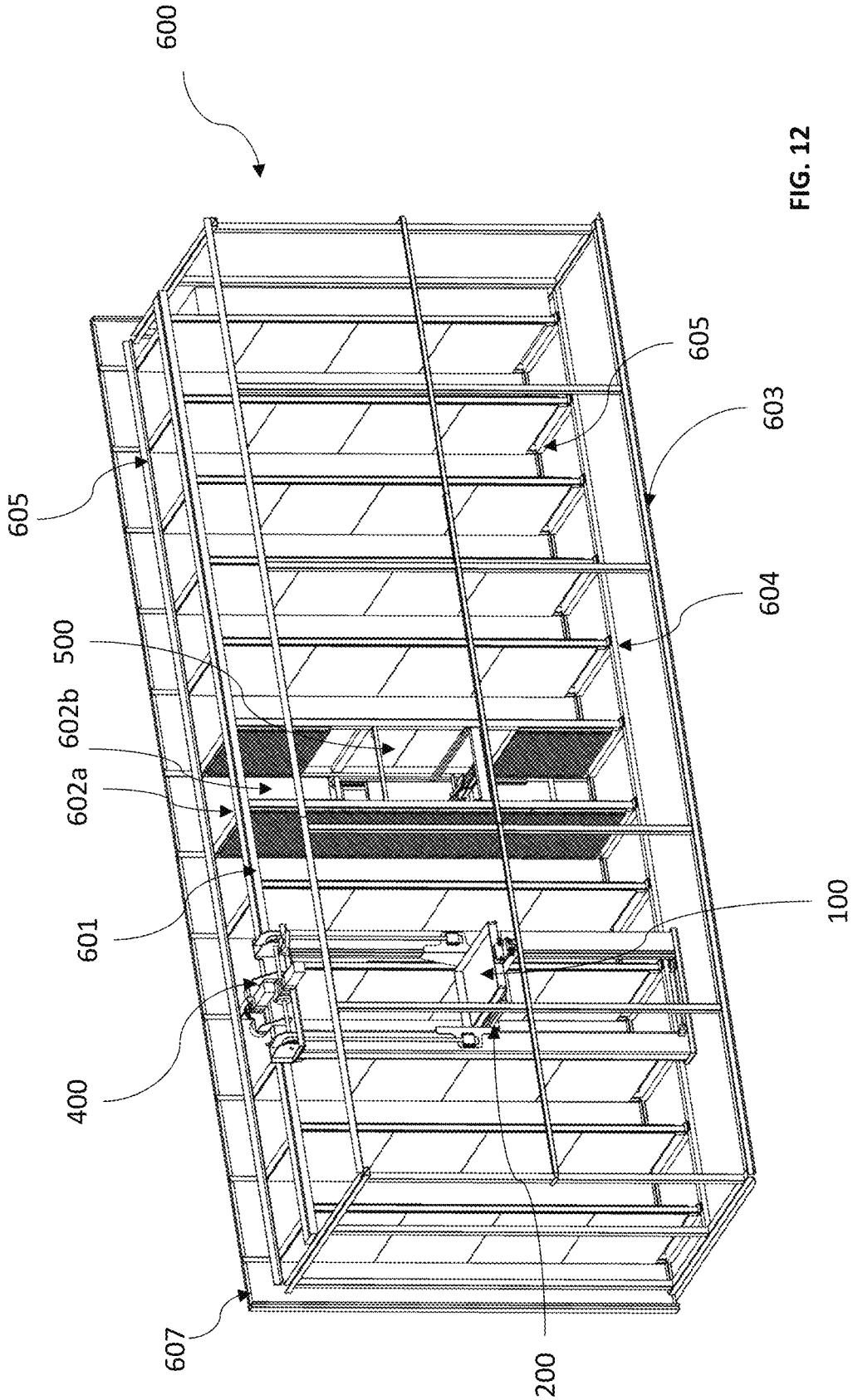
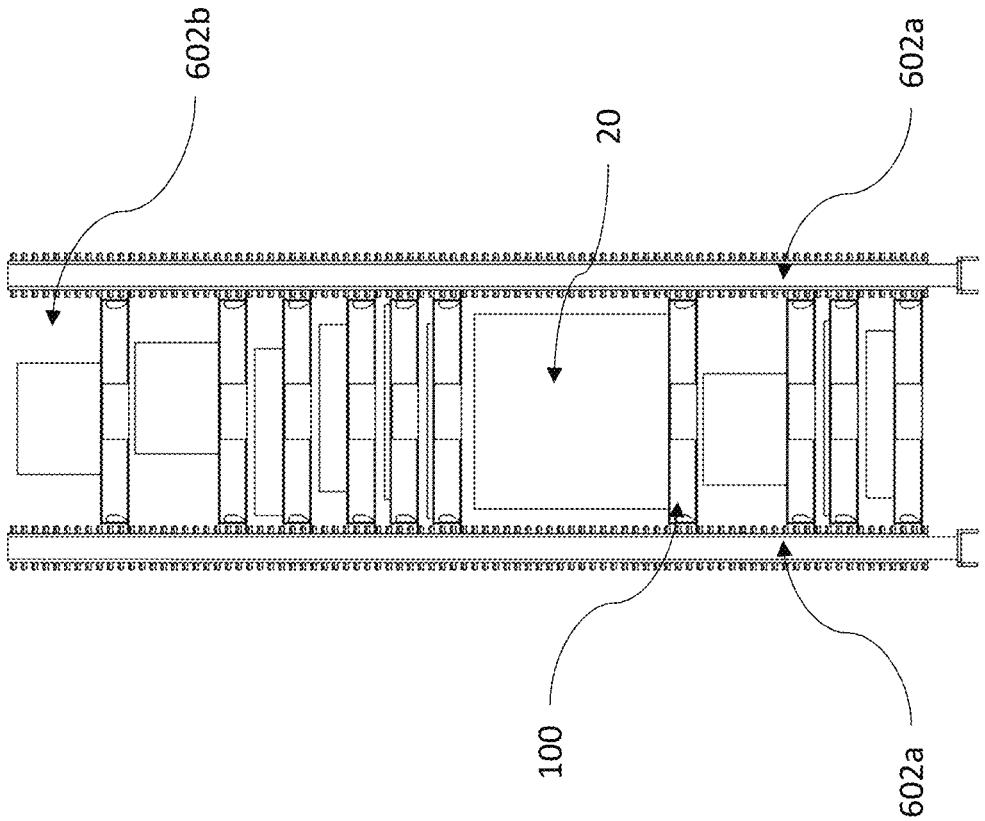


FIG. 12

FIG. 13



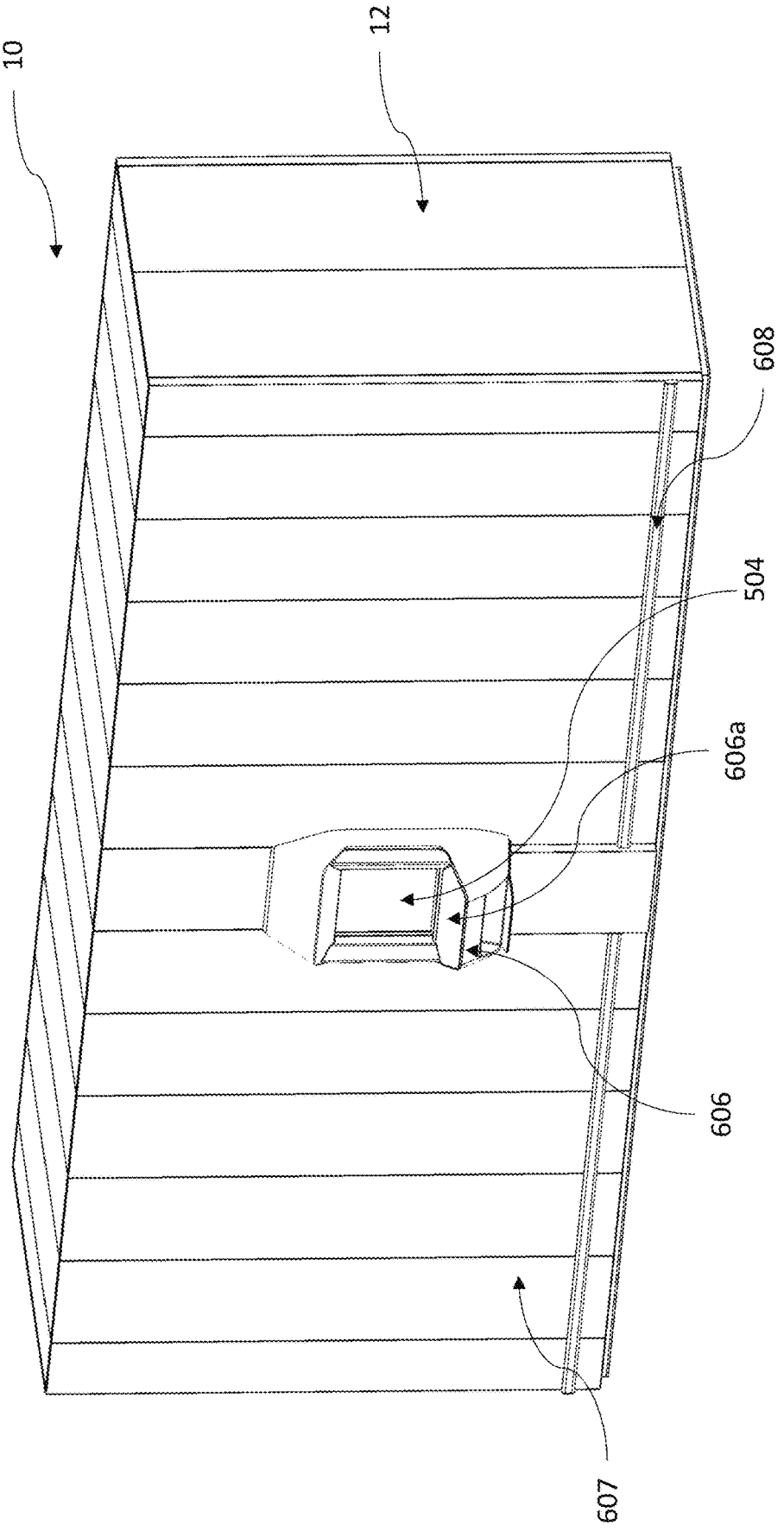


FIG. 14

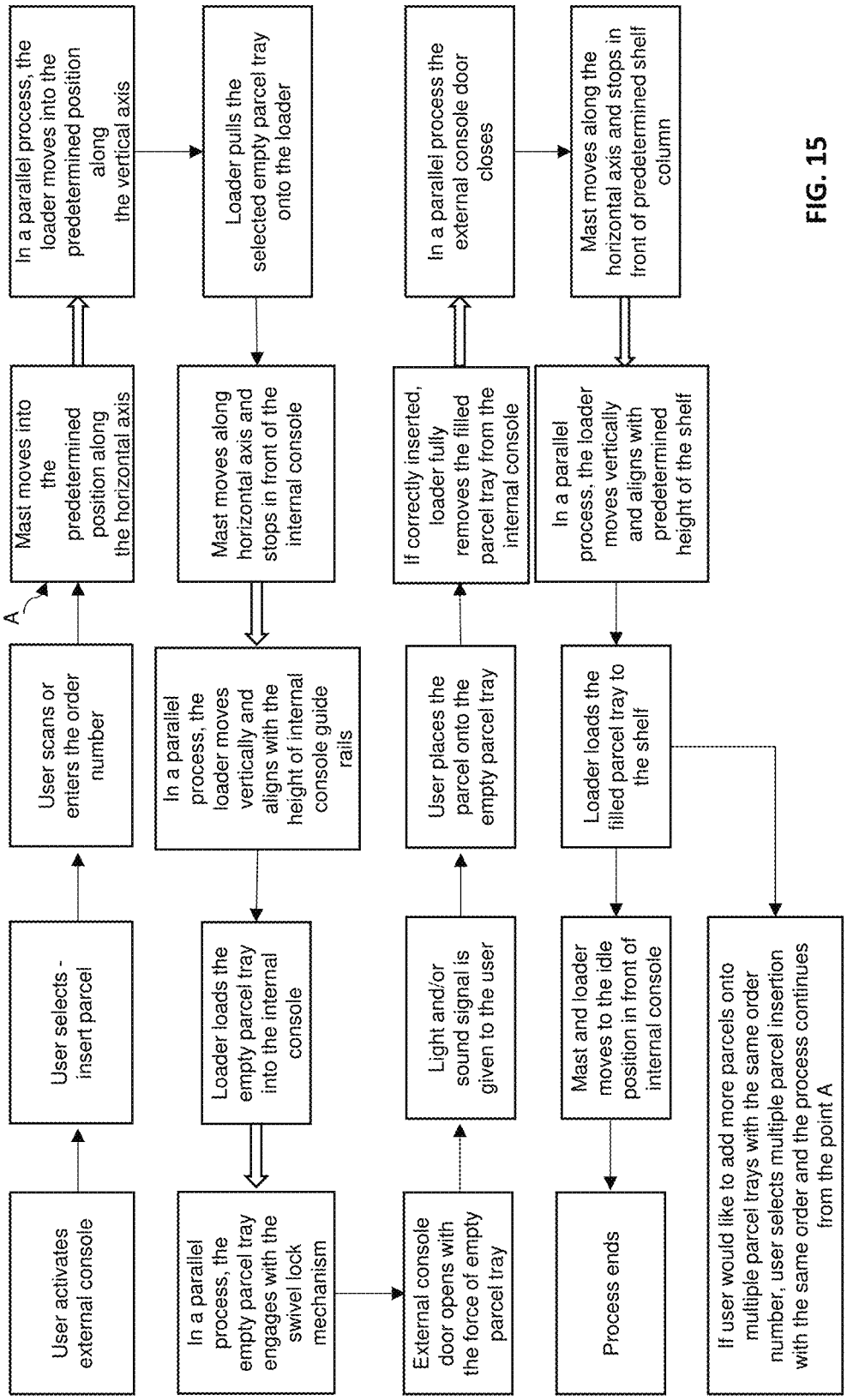

User activates external console
User selects - insert parcel
User scans or enters the order number
Mast moves into the predetermined position along the horizontal axis
In a parallel process, the loader moves into the predetermined position along the vertical axis
A
In a parallel process, the empty parcel tray engages with the swivel lock mechanism
Loader loads the empty parcel tray into the internal console
In a parallel process, the loader moves vertically and aligns with the height of internal console guide rails
Mast moves along horizontal axis and stops in front of the internal console
Loader pulls the selected empty parcel tray onto the loader
External console door opens with the force of empty parcel tray
Light and/or sound signal is given to the user
User places the parcel onto the empty parcel tray
If correctly inserted, loader fully removes the filled parcel tray from the internal console
In a parallel process the external console door closes
Process ends
Mast and loader moves to the idle position in front of internal console
Loader loads the filled parcel tray to the shelf
In a parallel process, the loader moves vertically and aligns with predetermined height of the shelf
Mast moves along the horizontal axis and stops in front of predetermined shelf column
If user would like to add more parcels onto multiple parcel trays with the same order number, user selects multiple parcel insertion with the same order and the process continues from the point A

FIG. 15

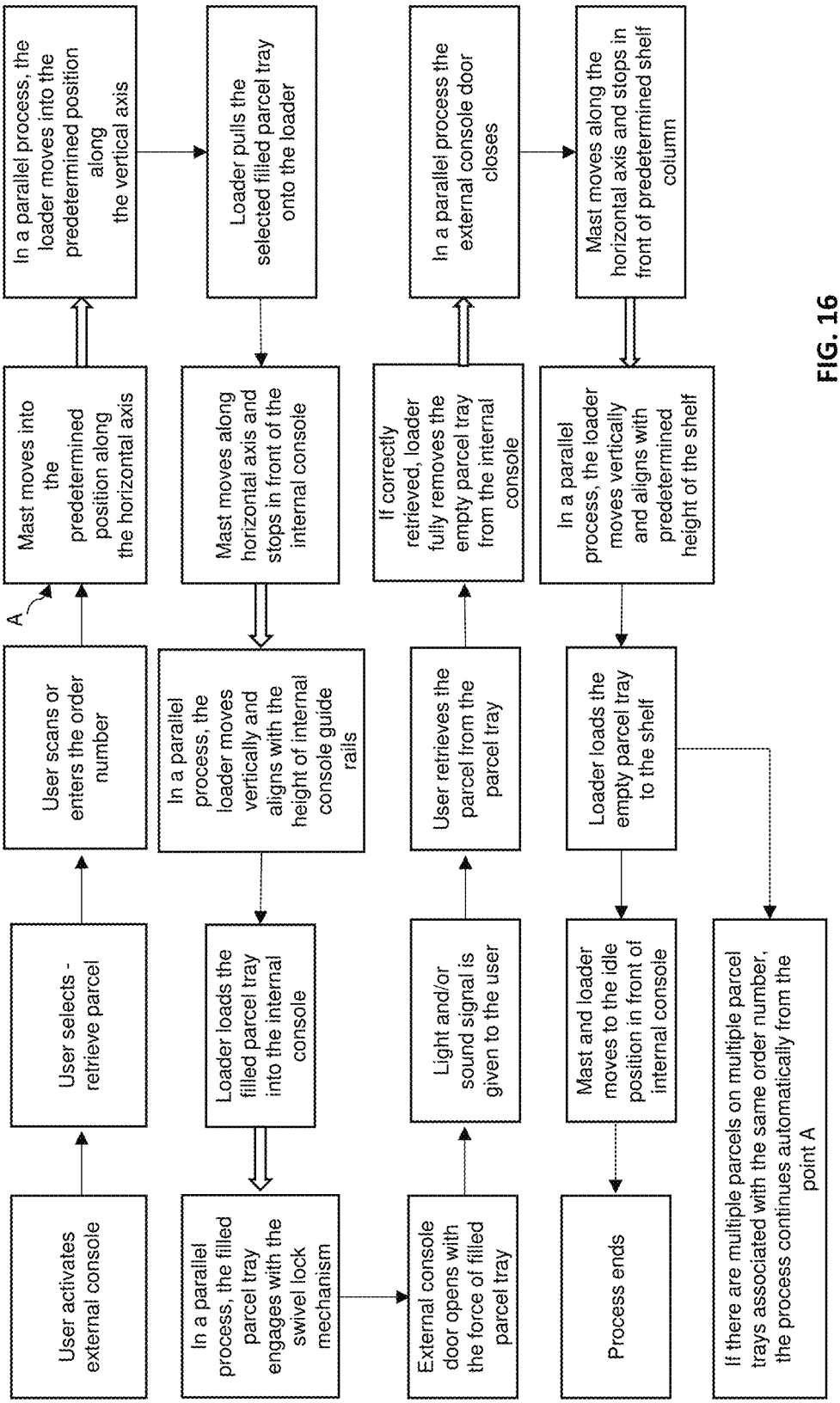

User activates external console
User selects - retrieve parcel
User scans or enters the order number
A
Mast moves into the predetermined position along the horizontal axis
In a parallel process, the loader moves into the predetermined position along the vertical axis
In a parallel process, the filled parcel tray engages with the swivel lock mechanism
Loader loads the filled parcel tray into the internal console
In a parallel process, the loader moves vertically and aligns with the height of internal console guide rails
Mast moves along horizontal axis and stops in front of the internal console
Loader pulls the selected filled parcel tray onto the loader
External console door opens with the force of filled parcel tray
Light and/or sound signal is given to the user
User retrieves the parcel from the parcel tray
If correctly retrieved, loader fully removes the empty parcel tray from the internal console
In a parallel process the external console door closes
Process ends
Mast and loader moves to the idle position in front of internal console
Loader loads the empty parcel tray to the shelf
In a parallel process, the loader moves vertically and aligns with predetermined height of the shelf
Mast moves along the horizontal axis and stops in front of predetermined shelf column
If there are multiple parcels on multiple parcel trays associated with the same order number, the process continues automatically from the point A

FIG. 16

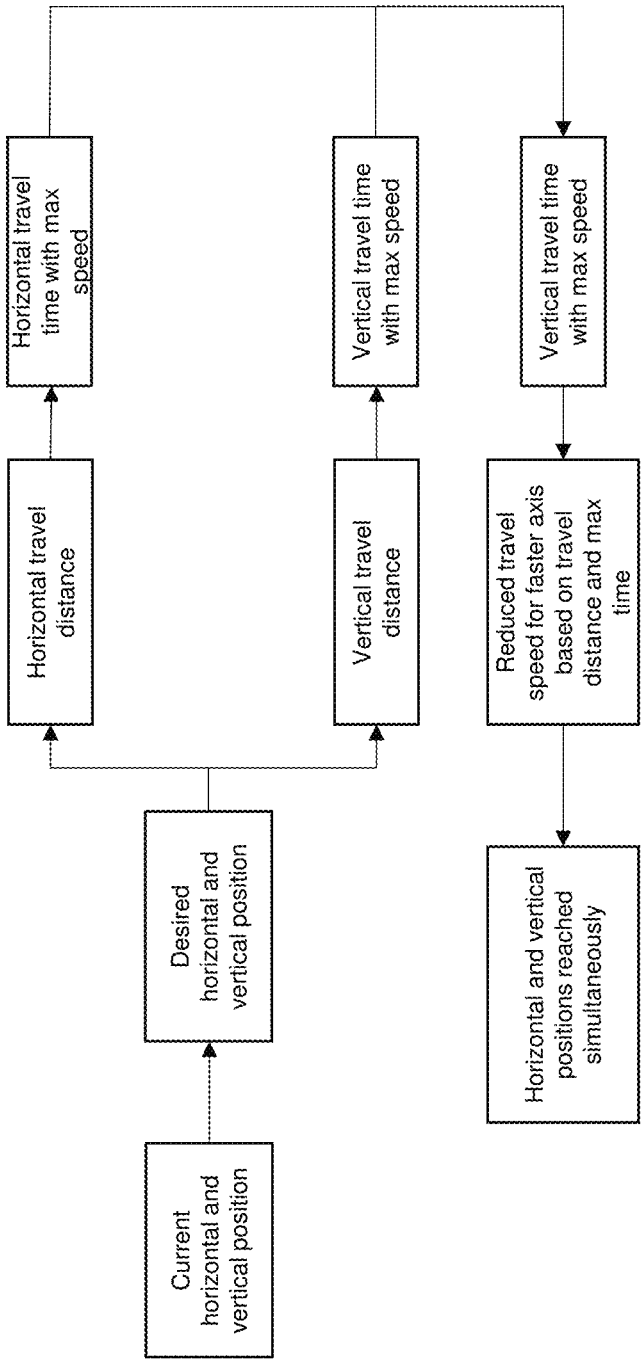

Current horizontal and vertical position
Desired horizontal and vertical position
Horizontal travel distance
Vertical travel distance
Reduced travel speed for faster axis based on travel distance and max time
Horizontal travel time with max speed
Vertical travel time with max speed
Vertical travel time with max speed
Horizontal and vertical positions reached simultaneously

FIG. 17

AUTOMATED PARCEL TERMINAL

PRIORITY

This application claims priority of U.S. provisional application No. 62/862,773 filed on Jun. 18, 2019 the contents of which is fully incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to the field of self-service parcel terminals, more specifically to the field of methods for delivery, sending, receiving and storing parcels, packages, mail and other postal objects.

BACKGROUND

Different parcel terminal solutions and processes used to control inserting and discharging postal objects are known from the prior art in which each parcel is stored in a separate locker or shelf. There are various known solutions for automated warehouse stacking solutions, e.g. US2016176633 and JP2017013948. For these kinds of solutions there are also numerous known solutions for cranes and loaders to move the parcels. Examples of such solutions are described in publications WO201806872 and US20150225216, among others.

Automated warehouse solutions, however, do not necessarily have features that are essential for self-service parcel terminal. These devices need to be designed for use of non-trained users and therefore the safety and simplicity will need to be addressed.

The simplest type of self-service terminal is a locker-type of terminal, where the customer has access to a specific locker. Examples of these devices and related methods are disclosed for example in U.S. Pat. Nos. 9,604,259 and 10,043,151, among others. In more complicated and advanced solutions the self-service terminal generally has an entry point at which parcels may be inserted into the terminal and received from the terminal. These devices generally have a transporting device moving inside the terminal and loading deposited parcels into shelves inside the terminal. Thus, the terminals have various automated moving parts. Examples of storage terminals with moving transporting device are disclosed for example in WO2018068072 or US 2012/0029687, among others.

When the system is a self-service terminal the terminal will be operated in addition to trained couriers by non-trained customers receiving their parcels. For this reason, it is utmost important that the terminal works in a way that no physical harm can be caused to non-trained users. The most obvious hazard would be the customer somehow getting his/her hands or arms stuck between closing doors or the customer otherwise being hurt by moving parts when operating the terminal.

In the known art, the terminals generally speaking have relatively complicated constructions preventing harm to the individual operating the terminal. As an example of the known art U.S. Pat. No. 9,242,810 provides a self-service parcel terminal for storing parcels of different sizes. The terminal comprises a gripping mechanism and lift system for moving parcels in the terminal between the shelves and the slot for inserting/delivering parcels. The slot for inserting and delivering parcels has a motorized door system with multiple doors.

The currently known solutions have complicated constructions, including moving mast with various levels of

complexity and various motors or drives to operate terminal doors for parcel entry and/or retrieval. In the currently known solutions safe operation of the terminals with complicated systems to control the door opening and closing also requires complicated safety systems. Such complicated systems also increase the costs of the devices which makes them too expensive for most of the small or middle-sized retail stores to use.

The speed of the parcel insertion and extraction is an essential feature of parcel terminals. In the previously known art, there are various methods to increase the speed of parcel insertion and extraction, however many of these methods require complicated structures, e.g. several insertion/retrieval areas. In self-service parcel terminal with one insertion and extraction point the movement speed of a mast and a loader lift are generally maximized to the strength limits of the participating elements. This approach increases the costs of the parcel terminals due to requirement of special parts and due to running the devices at their limits.

The current disclosure provides solutions to these problems as well as to others and provides a self-service parcel terminal that is fast, safe, durable and affordable.

SUMMARY

The current disclosure solves the above described shortcomings of the previous art and others. The disclosure provides a self-service terminal with an entry point that has a safe door opening system controlled mechanically by a tray inserted into the console. Closing the doors is also controlled mechanically when the tray is pulled away from the console. The self-service terminal according to this invention provides a structurally simplified moving mast and a safe door opening and closing system that does not require a separate motor or drive. Accordingly, the solution provided here is safe but economically more affordable than the devices known in the prior art. The device according to this disclosure can also be constructed to have a small size. Moreover, the device according to this disclosure operates quietly. With these features the device is specifically desirable for small retailers.

It is an object of this invention to provide an automated parcel terminal comprising: an outer shell and an internal structure; the outer shell comprising an external console for user identification, communication between the user and the terminal, and for retrieve or deposit a parcel; the internal structure comprising: at least one row of vertical shelf supports to adapt a multitude of parcel trays in between the supports, a mast moving horizontally along a top rail and a bottom rail and along the at least one row of shelf supports, a loader configured to move vertically on the mast and being capable of gripping a parcel tray with or without a parcel via an attachment mechanism, and moving the tray horizontally in direction perpendicular to moving direction of the mast, and an internal console located between two shelf supports within the at least one row of vertical supports; the internal console comprising: a support structure onto which a pair of parcel tray guiderails are attached, a console sliding door, light curtains, and a mechanism to operate the sliding door, wherein the mechanism to operate the sliding door comprises a horizontal slide supporting a swivel lock mechanism, a vertical slide comprising a counterweight, and an L-shaped drive belt loop connecting the swivel lock mechanism, the counterweight, and the console sliding door such that the door moves upward to a closed position and downward to open position via front-to-back movement of the swivel lock mechanism on the horizontal rail, and wherein

the door sliding downward to an open position is initiated when a parcel tray is pushed by the loader on to an end position on the guiderails, and the door sliding upward to a closed position is initiated when the parcel tray is pulled off by the loader from the guiderails and the counterweight moves the swivel lock mechanism to end of the horizontal slide where locking teeth engage with a locking pin so as to make it impossible to open the door from outside.

According to certain embodiments the attachment mechanism of the loader comprises a horizontally moving magnetic head on the loader and the parcel trays having a metal portion for an electromagnet of the magnetic head to attach.

According to certain embodiments the mast comprises a mast motor on top of the mast structure configured to move the mast horizontally in the parcel terminal and a lift assembly configured to move the loader vertically along the mast, wherein the lift assembly comprises: two vertical hollow beams both of which have vertical guiding grooves for adapting rollers of the loader to movably attach the loader in between the beams; a lift drive motor and a drive pulley system on top of the mast structure; and two open ended drive belts running partially inside the beams and having one end of each belt connected to the loader and the other end of each belt connected to a counterweight and the counter weight moving vertically inside the hollow beam and being guided along grooves on the inner surface of the beam.

According to certain embodiments the hollow beams of the lift assembly have a flat U-shape cross section and the counterweight moves vertically in the inner space of the U-shape.

According to certain embodiments, the counterweights of the lift assembly have sliders fitting into a groove in the surface of the hollow beam for guiding the movement of the counterweight.

It is another object of this invention to provide a mechanism to open and close a sliding door of an automated parcel terminal console, wherein the mechanism comprises an L-shaped continuous drive belt loop having a horizontal part and a vertical part, the drive belt looping around pulleys at both ends of its L-shaped form; a carriage supporting a swivel lock mechanism connected to the horizontal part of the drive belt, a counterweight connected to a back side of the vertical part of the drive belt loop and the sliding door connected to the front side of the vertical part of the drive belt loop, wherein the carriage is configured to move forward when a parcel tray is inserted into the internal console causing the drive belt loop to move to direction pulling the sliding door downward into an open position, and the carriage further being configured to move backward when the parcel tray is removed from the console causing the drive belt to move to direction pulling the sliding door upward into a closed position and the swivel lock to move to a locked position preventing opening of the door from outside.

It is yet another object of the invention to provide a method to operate a sliding door of a self-service parcel terminal, wherein the method comprises: opening the sliding door when: upon a loader inserting a parcel tray onto tray guiderails in an internal console of the terminal, end of the parcel tray engages with a swivel lock mechanism supported on a carriage on a horizontal slide in the internal console causing the mechanism to disengage from a locking pin, and upon the loader pushing the tray further into the internal console along the tray guiderails the carriage connected to a counterweight and to the sliding door, moves forward along the horizontal slide and causes the counterweight to move upward along a vertical slide and the sliding door moves down in an open position; and closing the sliding door when a loader pulling a parcel tray back from the internal console of the terminal, the carriage connected to the counterweight and to the sliding door, moves backward along the horizontal slide and causes the counterweight to move downward along a vertical slide and the sliding door moves upward in a closed position; and locking the door when end of the parcel tray disengages with a swivel lock mechanism on a horizontal slide in the console causing the swivel lock mechanism to engage with a locking pin locking the door in closed position.

According to certain embodiments the carriage, the counterweight and the sliding door are connected via an L-shaped drive belt loop.

According to certain embodiments the drive belt loop is arranged to L-shaped form via pullies at each end of the horizontal and vertical slides.

It is a further object of the invention to provide a computerized method to optimize operation of a parcel terminal having a horizontally moving mast and a vertically moving loader attached thereto, wherein the method comprises: obtaining coordinates of initial horizontal location of the mast and coordinates of initial vertical location of the loader; obtaining coordinates of desired horizontal location of the mast and coordinates of the desired vertical location of the loader; calculating a horizontal travel distance and a vertical travel distance based on the obtained coordinates of the initial horizontal location and the vertical location; calculating a horizontal travel time with a maximum speed based on the calculated horizontal travel distance and a vertical travel time with a maximum speed based on the calculated vertical distance; determining longer of the calculated horizontal and vertical travel times; and when the vertical travel time is longer, adjusting the horizontal speed of the mast such that the horizontal travel time is same as the vertical travel time, and when the horizontal travel time is longer, adjusting the vertical speed of the loader such that the vertical travel time is same as the horizontal travel time.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is an illustration of the parcel tray **100**. The figure shows a parcel **20** on the tray base **101**. On one end of the tray is shown a metal plate **102**.

FIG. **2** is an illustration of the loader **200**. The figure shows a U-shaped main frame **201** of the loader. Two guiderails **202** are mounted within the main frame at such distances from each other that the guiderails can support a tray when inserted onto the loader. In between and parallel to the guiderails **202** is mounted a linear guiderail system **204** which is formed of two guiderails. In between the two guiderails of the linear guiderail system **204** runs a drive belt system **205** along which a magnetic head **300** is moving. The guiderail system **204** extends at one end beyond the mainframe of the loader. The figure also shows the electric motor **203** attached to the U-shaped frame, and adjustable plates **210** attached on the vertical portions of the U-shaped frame. Adjustment screws **206** and rollers **209** are shown also.

FIG. **3** is an illustration of the magnetic head **300**. The magnetic head has an electromagnet **301**, two pushers **302** on both sides of the electromagnet, a housing **303** onto which the electromagnet and the pushers are attached. The magnetic head has additionally at least one sensor **304**.

FIG. **4** is an illustration of the mast. The mast **400** comprises of two vertical beams **408** that are supported from their lower ends by a bottom plate **406** and from their upper ends by a top plate **416**. The loader **200** is attached in

between the beams. On top of the top plate there is a mast drive motor **401** that moves with the mast. The motor is in connection with a drive belt system **403**. On top of the upper plate there is a carriage **402** comprising at an upper support roller **404** and a lower support roller **405** at each end of the carriage. The beams **408** are hollow and partially open on one side and have a groove **417** (shown in FIG. **7**) on their inner surface in which the counterweights **412** are moving.

FIG. **5** shows a vertical cross section of the mast top rail **601** and the upper **404** and lower **405** support rollers of the carriage. The cross section is taken perpendicularly to the moving direction of the mast. The support rollers fit snugly into the upper and lower mast rail contour (**601***a*, **601***b*).

FIG. **6** shows a vertical cross section of the mast bottom rail **604** and the bottom guide rollers **407**. The cross section is taken perpendicularly to the moving direction of the mast. The cross section of the rail has an L-shape such that the vertical prong of the L is in between the rollers.

FIG. **7** is an illustration of a horizontal cross section of a hollow and partially open, here U-shaped beam **408**, showing a counterweight **412** within the inner space of the U-shaped beam. There is a groove **417** running vertically along one inner wall of the beam along which a counterweight slider **418** slides. On the outer wall of the U-shaped beam opposite to the opening of the U-shape, there is a vertical guiding groove **419** for the roller **209** of the loader to fit in and guide vertical movement of the loader. The figure also shows the drive belt **411** of the loader and adjustable plate **210** through which the drive belt runs.

FIG. **8** is an illustration of the internal console **500** of the parcel terminal with the mechanism to open and close the sliding console door **504** from one perspective. The figure shows the support structure **501**, guiderails **502**, measurement curtains **503**, the sliding console door **504**, horizontal slides **505**, vertical slides **506**, the carriage **507**, the swivel lock mechanism **508**, the counterweight **509**, L-shaped drive belt loop **510**, drive belt pullies **511**, sliding door guiderails **512**, locking teeth **513**, locking pin **514**, light curtains **515**, a door home sensor **516**, and a counter **517** (which is also the upper edge of the sliding console door **504**).

FIG. **9** is an illustration of the internal console of the parcel terminal with the mechanism to open and close the sliding console door **504** from another perspective. The figure shows the support structure **501**, guiderails **502**, measurement curtains **503**, the sliding console door **504**, horizontal slides **505**, vertical slides **506**, the carriage **507**, the swivel lock mechanism **508**, the counterweight **509**, L-shaped drive belt loop **510**, drive belt pullies **511**, sliding door guiderails **512**, locking teeth **513**, locking pin **514**, light curtains **515**, a door home sensor **516**, and a counter **517** (which is also the upper edge of the sliding console door **504**).

FIG. **10** is a detailed illustration of the mechanism to operate the sliding console door **504**. The system includes horizontal slides **505** and vertical slides **506** that form an L-shaped structure along which an L-shaped drive belt loop **510** is arranged. The carriage **507** moves along the horizontal slides. The figure shows the swivel lock mechanism **508** (shown in more details in FIG. **11**). The counterweights **509** controlling the movement of the swivel lock mechanism move along the vertical slides.

FIG. **11** is an illustration of swivel lock mechanism of the internal console. The figure shows the parcel tray **100**, horizontal slides **505**, the carriage **507**, the swivel lock mechanism **508**, locking teeth **513**, locking pin **514**, and spring mechanism **519**.

Movement of the swivel lock mechanism is arranged such that it is controlled by insertion and removal of the parcel tray into and from the internal console. When the parcel tray **100** is not engaged with the swivel lock mechanism **508**, the force from the counterweight (**509** shown in FIG. **10**) moves the swivel lock mechanism backward (away from the sliding door of the internal console) on the horizontal slides **505** where the locking teeth **513** engage with the locking pin **514** due to the pressure from a spring mechanism **519**.

FIG. **12** is an illustration of the internal structure **600** of the parcel terminal. The figure shows the mast top rail **601**, and mast bottom rail **604** along which the mast **400** moves. The outer frame **603** is covered with sheet metal panels **607**. The figure shows the shelf supports **602***a* and shelf columns **602***b*. The loader **200** and a parcel tray **100** are also shown.

FIG. **13** is an illustration of the shelf structure **602** having a shelf column **602***b* between two shelf supports **602***a*.

FIG. **14** is an outside view of the parcel terminal having an outer shell **12** and external console **606** preferably on a long end of the terminal. The external console locates such that it provides access to the internal console to retrieve or deposit a parcel when the console sliding door **504** is open. The console sliding door **504** is shown in closed position.

FIGS. **15-16** illustrate flow chart of operations of the terminal.

FIG. **17** illustrates a flow chart of mast and loader synchronization.

DETAILED DESCRIPTION OF THE INVENTION

An automated indoor self-service parcel terminal for the storage and handover of pre-ordered items is disclosed here. The automated parcel terminal **10** according to this invention comprises an outer shell **12**, an external console **606**, an internal console **500**, a mast **400**, a loader **200**, and an internal structure **600**. The internal structure comprises a multitude of vertical shelf supports for storing items of different sizes on parcel trays inserted in between of two shelf supports **602***a*. For the clarity of the description the area in between any two adjacent shelf supports form a shelf column **602***b* and the trays can be stored in any shelf column. Detailed description is provided below with reference to the appended drawings.

Parcel Tray

The automated parcel terminal **10** uses parcel trays **100** to store different sized goods (parcels) **20** and to move them inside the terminal. A schematic illustration of a tray is shown in FIG. **1**. The use of trays allows to store goods in various sizes and ambiguous shapes without imposing strict requirements on their packaging. As is shown in FIG. **1**, the parcel tray comprises a tray base **101** and a metal plate (preferably steel plate) **102** on one end. The steel plate is an attachment point for the electromagnet **301** that is used to move the parcel tray onto and off the loader, perpendicularly to the drive path of the mast.

The parcel tray base **101** preferably has chamfered corners and tapered sides to guide the parcel tray in between of two shelf support columns or to the loader. The tray base can be made of different materials including but not limited to steel, stainless steel, different thermoplastics and composites. According to certain embodiments the parcel tray does not have the steel plate **102** when other than electromagnet is used as means of attachment. According to certain embodiments the attachment means not requiring the steel

plate may be suction cups. According to certain embodiment the material of the tray is easily magnetizable and the steel plate is not necessary in such case.

Loader

FIG. **2** illustrates the loader. The loader **200** has a substantially U-shaped main frame **201**, which acts as a connection point for all other parts of the loader. Placed within the substantially U-shaped main frame is a pair of guiderails **202** mounted at such distance from each other that they guide the parcel tray **100** when it moves along the loader on top of the guiderails. The length of the guiderails **202** preferably equals to deepness of the main frame. The guiderails are mounted onto the main frame and can be easily replaced, if necessary. The material of the guiderails is highly durable and strong, such as polyoxymethylene i.e. polyacetal or similar, which ensures their long life and the capacity to carry maximum weight parcel trays. Guiderails **202** have preferably tapered ends to guide the parcel tray **100** onto the loader while it is being pulled from a shelf column.

In between of and parallel to the guiderails **202**, there is a linear guiderail system **204** mounted for a magnetic head **300** to move on. According to a preferred embodiment the guiderail system extends beyond the main frame of the loader at least at one end. The magnetic head is illustrated in detail in FIG. **3**. The magnetic head has an electromagnet **301** aligned with the linear guiderail system and pointing toward the shelf columns on one side of the parcel terminal. In an alternative embodiment the magnetic head is double-sided, which would enable the loader to pick up parcel trays from both sides of the loader. According to a preferred embodiment, the loader is capable of moving parcel trays to and from the parcel terminal's internal console (**500** in FIG. **12**) and to and from the shelf columns **602***b* (area between two shelf supports **602***a* in FIG. **12**). As is shown in FIG. **2**, the magnetic head is mounted onto linear guiderail system **204**. In addition to the electromagnet, the magnetic head comprises at least one pusher, preferably two pushers **302**, and a housing **303** that joins the components together. The electromagnet can move in relation to the housing, which makes it possible to compensate for any potential parcel tray loading or loading position inaccuracies. The electromagnet hangs over from the housing to the extent that is necessary to reach across the edge of the loader to grab parcel trays placed in the shelf columns. The pushers are preferably located on opposite sides of electromagnet. The pushers are connected to a sensor **304** that provides a signal to define whether the parcel tray is attached to the electromagnet. The pushers also help to push the parcel tray away from the electromagnet if any residual magnetism should occur, to ensure that the parcel tray is not attached to the magnetic head when the mast or mast lift starts moving.

The magnetic head is moved via an electric motor **203** and drive belt system **205** shown in FIG. **2**. The drive belt has easy access adjustment screws **206** on both ends of the loader that allow to change the angle of the endmost rollers of the drive belt system to ensure that the movement of the drive belt is as linear as possible and also to adjust the belt's tension. The drive belt system with rollers is placed between two plates **207** that stretch along the entire length (depth) of the loader. There is a home sensor **208** for the magnetic head at one end of the loader.

The loader is positioned relative to the mast via rollers **209** located at both vertical portions of the loader's main frame. The rollers are mounted onto the main frame **201** such a manner that they are easily replaceable. These rollers are preferably covered with polyurethane layer to ensure longevity and silent movement along the mast beams. The rollers position the loader on the mast along the moving direction of the magnetic head and along the drive direction of the mast. FIG. **7** shows the role of the rollers **209** in attaching the loader to the beams **408** of the mast. There is a vertical guiding groove **419** on the outer wall of the beam for the roller **209** fit in and guide the vertical movement of the loader. To compensate for the manufacturing tolerances of the loader and to ensure that the guiderails **202** of the loader always form a horizontal plane parallel to the corresponding shelf columns, two vertically adjustable plates **210** are used to attach the loader to drive belts on the lift assembly (FIG. **7** shows the connections between the adjustable plates and the drive belts).

Mast

FIG. **4** illustrates the mast. The mast comprises two vertical beams **408**, a bottom plate **406** that supports the beams from their lower end and a top plate **416**. The mast **400** is driven along the mast top rail **601** (shown in FIG. **12**) and on a mast bottom rail **604** along an aisle between the shelf supports **602***a* (shown in FIG. **12**) and outer frame of the parcel terminal **603** (FIG. **12**) or alternatively between two rows of shelf supports in an alternative embodiment. Power transmission is achieved through a mast's drive belt **420** running along the mast top rail **601**, fixed to the rail at its both ends. At one end of the rail there is a drive belt tensioning system. A mast drive motor **401** is located on top of the mast top structure and it moves with the mast. The upper section of the mast comprises a carriage **402**, through which the mast is connected to the top rail **601** and to the mast's drive belt **420**.

The carriage **402** holds the rollers **403** of the drive belt system through which power is transmitted to the drive belt. The drive system uses an omega type belt routing to ensure maximum number of belt teeth connecting to the drive wheel and to hold the belt as close to the mast rail as possible. The system preferably has two omega drive idlers that are adjustable in two axes to ensure the drive belt runs as linear as possible along the entire length of the machine.

The carriage also holds upper support rollers **404** and lower support rollers **405**, through which the mast is connected to the top rail **601** (connection is illustrated in FIG. **5**). The rollers are driven in two contours **601***a* and **601***b* of the mast top rail. The contours may be substantially V-shaped, U-shaped, or of rectangularly shaped. Upper support rollers support the weight of the mast assembly and define the position of the mast. The position of lower support rollers is adjustable in vertical direction to compensate for manufacturing tolerances. These rollers ensure that no tilting of the mast out of the vertical plane takes place when the mast is being accelerated or deaccelerated. Both pairs of rollers are preferably covered with polyurethane layer to ensure longevity and silent movement along the machine. The mast may have different number of rollers depending on the loads of the given mast needs to carry. The rollers are mounted to the carriage in a way that they are easily replaceable.

As shown in FIGS. **4** and **6**, the bottom section of the mast comprises a bottom plate **406** and preferably two pairs of bottom guide rollers **407**. The position of bottom guide rollers is adjustable perpendicular to the mast's driving direction to ensure that the mast can be positioned parallel to the shelf columns. FIG. **6** shows the bottom rail having an L-shaped cross section and the vertical prong of the

L-shaped bottom rail fits in between a pair of rollers. The rollers are driven along the mast bottom rail **604** and they ensure that no back and forth tilting of the mast out of the vertical plane takes place while loading or unloading parcel trays.

Referring to FIGS. **4**, **5**, and **7**, the mast has a lift assembly configured to move the loader **200** vertically along the mast. The lift assembly comprises two hollow, partially open sided beams **408** that include preferably a U-shaped (although other shapes, such as V-shape, flat U-shape are also possible) guiderails **419** in inner sides of the beams for the rollers **209** of the loader (see also FIG. **7**). (By inner side here it is meant the side of the beam that faces toward the loader.) Lift drive motor **409** is attached to the mast carriage **402** and is preferably located underneath the mast drive motor (FIG. **4**). Power transmission for the lift assembly is achieved through drive pulley systems **410** and two open ended drive belts **411** running partially inside the hollow beams **408**. One end of each belt is connected to the loader (see FIG. **7**) while the other end of each belt is connected to counterweight **412** (FIG. **7**). The counterweights are guided along the beams **408** in vertical grooves **417** on an inner surface of each hollow beam to ensure silent movement while the mast is being accelerated or deaccelerated. FIG. **7** is an illustration of horizontal cross section of a beam **408** having a flat U-shape. The figure shows the counterweight **412** inside the hollow beam, a vertical groove **417** on the inner surface of the hollow beam **408** wherein a slider **418** of the counter weight fits in, and the roller **209** in a guide rail on the inner side of the beam. (For clarification inner side of the beam means here the side of the beams that faces toward the loader while the outer side means the sides that face away from the loader.) The figure shows the main frame **201** of the loader as well as an adjustable plate **210** of the main frame of the loader. The figure illustrates the connections between the beam, the loader and the drive belt and counterweight of the lift assembly.

A homing sensor for the mast **413** is located at one end of the carriage while a camera **414** to observe the loader in operation is located at the other end. Homing sensor for loader's vertical movement is located at the bottom part of the mast **415**.

Internal Console

Referring now to FIGS. **8** and **9**, the internal console **500** of the parcel terminal enables placement and retrieval of parcels. The internal console comprises a support structure **501** to which a pair of horizontal parcel tray guiderails **502** are attached. The guiderails are easily replaceable and made of highly durable material such as polyoxymethylene i.e. polyacetal or similar, which ensures their long life and the capacity to carry maximum weight parcel trays. According to one embodiment, next to the guiderails preferably on the support structure **501** are measurement curtains **503** to register the height of the parcel when the magnetic head **300** pulls the parcel tray holding a parcel out of the internal console and onto the loader **200**. The height measurement information is registered by the computerized system of the terminal and enable the automated terminal to distribute the received parcels inside the terminal in most optimal manner.

The mechanism to operate the console sliding door **504** is located below the guiderails in the internal console (FIG. **8**, **9**). FIG. **10** illustrates the construction of the mechanism. The mechanism includes horizontal slides **505** and vertical slides **506**. A carriage **507** which supports a swivel lock mechanism **508** is attached onto the horizontal slides. A counterweight **509** is attached to the vertical slides. Operation of the swivel lock mechanism is shown in detail in FIG. **11**. An L-shaped drive belt loop **510** connects the swivel lock mechanism, the counterweight and the console sliding door **504** into a single system. The L-shape of the drive belt loop is formed by drive belt pullies **511** that locate at the ends of the vertical and horizontal slides. The pullies are adjustable to ensure that the belt runs as straight as possible between the vertical and horizontal slides. The sliding door **504** connects to the front side of the drive belt loop. In FIG. **9***a* lower edge of the sliding door is attached to the front side of the L-shaped drive belt loop). The sliding door **504** is supported on its sides by guiderails **512**. The counterweight **509** is connected to the back side of the belt loop (FIG. **8**). According to one embodiment the connection is made by a bracket **520** as is shown in FIG. **8**. The drive belt **510** loops around the pulleys **511**. The door moves up and down with the front-to-back movement of the swivel lock mechanism such that when the front side of the belt loop moves up when the swivel lock mechanism moves backward (away from the sliding door), the back side of belt loop along with the counter weights moves downward and the sliding door **504** moves upward to a closed position closing the entrance to the internal console. When the swivel lock mechanism moves forward the front side of the drive belt loop moves down, the counterweights move upward, and the door moves downward to an open position to open the entrance to the inner console. The size of the counterweight is chosen such that gravitational pull on the counterweight exceeds the gravitational pull on the sliding door and internal forces in the mechanical system. At the same time the force is low enough to avoid personal injury while placing a hand in the movement path of the sliding door while the door moves up (i.e. closes).

Movement of the swivel lock mechanism is arranged such that it is controlled by insertion and removal of the parcel tray into the internal console. Operation of the swivel lock mechanism is illustrated in FIG. **11**. When the parcel tray is not engaged with the swivel lock mechanism, the force from the counterweight always moves the swivel lock mechanism to the end (away from the sliding door) of the horizontal slides where the locking teeth **513** engage with the locking pin **514** due to the pressure from a spring mechanism **519** (FIG. **11**) The profile of the locking teeth is chosen such that it is impossible to open the sliding door from outside while the swivel lock mechanism is engaged with the locking pin.

When the loader's magnetic head pushes the parcel tray into the console guiderails **502**, the tray end engages with the swivel lock mechanism which swivels and consequently the locking teeth disengage from the locking pin (see FIG. **11**). The carriage **507** holding the swivel lock is pushed to the other end of the horizontal slides (toward the sliding door) while at the same time the sliding door is moved down (open) and the counterweight moves up. In order to ensure safe operation of the sliding door a pair of light curtains (safety curtains) **515** is placed in front of the sliding door. While these light curtains are obstructed the movement of the loader's magnetic head is stopped to ensure that the user/customer cannot place his or her hand between the sliding door and arriving parcel tray. The operational profile of the loader's magnetic head when engaging with the swivel lock is configured in such a manner that the movement of the door is carried out without sudden accelerations and silently as possible. There is a door home sensor **516** at the upmost position of the door to register the locked state of the door and switch off the signal from the light curtains. The sliding door opening mechanism enables to operate the

sliding door with the loader's magnetic head/parcel and without a special dedicated motor.

The counter **517** of the internal console on top of the sliding door is made from high surface hardness material such as brushed stainless steel or anodized aluminum to ensure good resistance to scratches that can occur during parcel handling. The counter acts as a supporting surface when inserting or retrieving parcels as parcels can be placed on it and pushed onto the tray.

Optical sensors **518** are placed at the ends of the parcel tray guiderails **502** to detect widthwise oversize parcels. These sensors detect oversize while the parcel is being pulled onto the loader from the internal console. If any oversize is detected, the parcel tray is pushed back into the internal console.

Internal Structure

Referring now to FIG. **12**, the internal structure **600** of the terminal consists mainly of shelf supports **602***a* that form platforms between them to provide support for the parcel trays so parcels can be stored. The shelf supports **602***a* are joined together by the mast top rail **601**, mast bottom rail **604** and multitude of support beams **605**. All these components can be manufactured from single items or jointed items. FIG. **13** shows the shelf structure **602** showing the elements in more detailed manner.

The shelf supports form one row inside the parcel terminal and leave an unobstructed section or an aisle for the mast. It may also be noted that in an alternative embodiment of the system, shelf supports can form two rows inside the parcel terminal, leaving an unobstructed middle section (aisle) for the mast. An area between one pair of shelf supports is used for internal console to facilitate insertion and retrieval of parcels. The location of the internal console can be chosen freely along the length of the parcel terminal.

Outer Shell and External Console

FIG. **14** shows an outer view of the parcel terminal and shows the external console **606**. The external console serves as an interaction area of the terminal. The sliding console door **504** of the internal console opens to the external console for the user to insert or pick up the package. In FIG. **14** the sliding console door is shown in closed position. According to a preferred embodiment the external console comprises a shell, a user interface e.g. a touch screen **606***a*, two scanners and an ADA (Americans with Disabilities Act)-compliant headphone jack with a volume control button. In order to gain easy access to these items for maintenance purposes the external console can be opened for example via hinge mechanism.

The outer shell of the terminal is preferably composed by interlocking sheet metal panels **607** which are fixed onto the shelf columns and outer frames of the inner structure. The pitch of the sheet metal panels matches the pitch of the shelf columns, thus enabling easy modularization of the parcel terminals length. The panels can be covered as desired, e.g. different color choices, advertisement areas etc. The panels cover the parcel terminal from all four sides and from above. An anti-collision bollard **608** is attached to the outer shell to preserve the visual look of the parcel terminal in areas where shopping carts are used and may collide with the panels.

Operation Logic of the Terminal

FIGS. **15**, and **16** illustrate flow chart of operations of the terminal. The self-service parcel terminal may be connected to a server in order to process data, generate user and parcel codes and for identifying users with the web application or smart device application, as well as sending data to the parcel terminal. The self-service parcel terminal may include computing hardware for carrying out the above-noted processes of FIGS. **15**, and **16**, as well as other functionalities, steps, etc. of this disclosure. In an embodiment, the self-service parcel terminal may include a first computing device, such as a general purpose computer having a computer-readable memory with instructions and a processor executing those instructions, that provides the user interface, effects communications with the server, and initiates commands to move the mast, the loader, and other mechanical components of the terminal. The terminal may further include a second computing device that controls the precise movement of the mast, the loader and other mechanical components. The second computing device may receive movement commands from the first processing device and transmit movement instructions to the mechanical components. In one embodiment the second computing device may be a programmable logic controller (PLC). The second computing device may also control other processes, in an embodiment, responsive to input from the scanner and/or first computing device. It should be noted that, although specific computing hardware is noted above for the first and second computing devices, any type of appropriate computing hardware may be used for any computing device in the self-service parcel terminal, including but not limited to a general-purpose computer, a PLC, another programmable logic device (PLD), an application-specific integrated circuit (ASIC), etc. It is obvious that the same self-service parcel terminal may work as local device without any help of server if pre-programmed so. Further, it should be noted that functions, processes, steps, etc. of this disclosure that are carried out by such computing devices may be embodied in any combination of software, digital hardware, and analog hardware. Still further, although two computing devices are explicitly described above, it should be appreciated that the functions, processes, steps, etc. of this disclosure may be carried out by a single computing device, by two computing devices, or by more than two computing devices of the self-service parcel terminal.

Parcel Entry

1. User touches the display at the external console **606** and the display becomes active.
2. User selects "parcel entry/insert parcel" from the display.
3. User scans or enters the order number.
4. Registry software forwards the horizontal and vertical co-ordinates of the nearest empty parcel tray **100** to the terminal's operational software.
5. Mast drive motor **401** engages with the drive belt **420** and moves the mast **400** horizontally into front of the designated pair of shelf supports **602***a*.
6. Simultaneously the lift drive motor **409** engages with the pulley system **410** and lift drive belts **411** and moves the loader **200** vertically into front of/to the height of the empty parcel tray **100** between the pair of shelf supports **602***a* (counterweights **412** move vertically in the opposite direction).
7. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** horizontally against the steel plate **102** of the parcel tray **100** between the pair of shelf supports **602***a*.

8. At the end position of the magnetic head **300**, the electromagnet **301** is engaged and attaches the parcel tray **100** onto the magnetic head **300**.
9. Sensor **304** registers attachment of the parcel tray **100**.
10. Loader's electric motor **203** is reversed and moves the magnetic head **300** with the parcel tray **100** out from the shelf column **602***b* (formed in between the pair of shelf supports **602***a*).
11. Home sensor **208** registers retrieval of the magnetic head **300**.
12. Mast drive motor **401** engages with the drive belt and moves the mast **400** horizontally in front of the internal console **500**.
13. Simultaneously the lift drive motor **409** engages with the pulley system **410** and drive belts **411** and aligns the loader (to the height of console's guiderails) **200** vertically with the guiderails **502** in the internal console **500**.
14. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** with the parcel tray **100** horizontally into the internal console **500**.
15. Simultaneously end of the parcel tray **100** engages with the swivel lock mechanism **508**, the mechanism swivels and disengages from the locking pin **514**.
16. Door home sensor **516** registers opening of the door and light curtains **515** are engaged.
17. The magnetic head **300** continues to push the parcel tray into the internal console **500** while the carriage **507** moves horizontally along the horizontal slides **505**, door counterweight **509** moves up along the vertical guiderails **506** and console sliding door **504** moves down toward open position along the guiderails **512**.
18. Magnetic head **300** with the parcel tray **100** reach their end position along the guiderails **502** and loader's electric motor **203** is disengaged.
19. Light and/or sound signal is given to the user.
20. User places the parcel onto the parcel tray **100**.
21. Light curtains **515** register the placement of the parcel.
22. Loader's electric motor **203** engages with the drive belt system **205** and pulls the magnetic head **300** horizontally with the parcel tray **100** out of the internal console **500**.
23. Simultaneously the carriage **507** moves horizontally along the horizontal slides **505** (still supported by the parcel tray) from the force of the counterweight **509** while the counterweight **509** moves down along the vertical guiderails **506** and console sliding door **504** moves up to a closed position along the guiderails **512**.
24. At a certain point, locking teeth **513** of the swivel lock mechanism **508** engage with the locking pin **514** due to the pressure from a spring mechanism **519** and movements of the console sliding door **504** and counterweight **509** are stopped.
25. Door home sensor **516** registers closing of the door and light curtains **515** are disengaged.
26. Loader's magnetic head **300** moves away from the locked swivel lock mechanism **508** and the parcel tray **100** is pulled out of the internal console **500**.
27. Optical sensors **518** detect that the parcel is not oversized widthwise. If any oversize is detected, the parcel tray **100** is pushed back into the internal console **500**.
28. Measurement curtains **503** register the height of the parcel.
29. Registry software finds an optimal location for the parcel in between the shelf supports **602***a* based on its height and forwards the parcel's horizontal and vertical co-ordinates to the machine's operational software.
30. Home sensor **208** registers retrieval of the magnetic head **300**.
31. Mast drive motor **401** engages with the drive belt and moves the mast **400** horizontally to front of the designated pair of shelf supports **602***a*.
32. Simultaneously the lift drive motor **409** engages with the pulley system **410** and lift drive belts **411** and moves the loader **200** vertically in front of the designated parcel location between the pair of shelf supports **602***a* (i.e. in front of the target shelf in shelf column **602***b*) (counterweights **412** move vertically in the opposite direction).
33. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** horizontally with the parcel tray **100** into between two shelf supports **602***a* (i.e. to the shelf nr XX).
34. At the end position of the magnetic head **300** the loader's electric motor **203** is disengaged, electromagnet **301** is disengaged and pushers **302** push the parcel tray **100** off from the magnetic head **300**.
35. Sensor **304** registers unattachment of the parcel tray **100**.
36. Loader's electric motor **203** is reversed and moves the magnetic head **300** without the parcel tray **100** out from the shelf column between the pair of shelf supports **602***a*.
37. Home sensor **208** registers retrieval of the magnetic head **300**.
38. Mast **400** and loader **200** are placed into their parking positions/idle position in front of the internal console **500** and the cycle is completed.
39. Alternatively, if the user would like to add more parcels **20** onto multiple parcel trays **100** with the same order number, user selects multiple parcel insertion with the same order and the process continues from the point **4**.

Parcel Retrieval

1. User touches the display at the external console **606** and the display becomes active.
2. User selects "parcel retrieval" from the display.
3. User scans or enter the order number.
4. Registry software matches the order number with the parcel location in the machine and forwards the parcel's horizontal and vertical co-ordinates to the machine's operational software.
5. Mast drive motor **401** engages with the drive belt and moves the mast **400** horizontally in front of the designated pair of shelf supports **602***a*.
6. Simultaneously the lift drive motor **409** engages with the pulley system **410**, drive belts **411** and moves the loader **200** vertically in front of the designated parcel tray **100** in the pair of shelf supports **602***a* (counterweights **412** move vertically in the opposite direction).
7. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** horizontally against the steel plate **102** of the parcel tray **100** locating in the shelf column **602***b* between the pair of shelf supports **602***a*.
8. At the end position of the magnetic head **300**, the electromagnet **301** is engaged and attaches the parcel tray **100** onto the magnetic head **300**.
9. Sensor **304** registers attachment of the parcel tray.
10. Loader's electric motor **203** is reversed and moves the magnetic head **300** with the parcel tray **100** out from the shelf column **602***b* between the pair of shelf supports **602***a*.
11. Home sensor **208** registers retrieval of the magnetic head **300**.
12. Mast drive motor **401** engages with the drive belt and moves the mast **400** horizontally in front of the internal console **500**.

13. Simultaneously the lift drive motor **409** engages with the pulley system **410** and drive belts **411** and aligns the loader **200** vertically with the guiderails **502** in the internal console **500**.
14. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** horizontally with the parcel tray into the internal console **500**.
15. End of the parcel tray **100** engages with the swivel lock mechanism **508**, the mechanism swivels and disengages from the locking pin **514**.
16. Door home sensor **516** registers opening of the door and light curtains **515** are engaged.
17. The magnetic head **300** continues to push the parcel tray into the internal console **500** while the carriage **507** moves horizontally along the horizontal slides **505**, door counterweight **509** moves up along the vertical guiderails **506** and console sliding door **504** moves down to an open position along the guiderails **512**.
18. Magnetic head **300** with the parcel tray **100** reach their end position along the guiderails **502** and loader's electric motor **203** is disengaged.
19. Light and/or sound signal is given to the user.
20. User removes the parcel from the parcel tray **100**.
21. Light curtains **515** register removal of the parcel.
22. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** horizontally with the parcel tray out of the internal console **500**.
23. Simultaneously the carriage **507** moves horizontally along the horizontal slides **505** (still supported by the parcel tray) from the force of the counterweight **509** while the counterweight **509** moves down along the vertical guiderails **506** and console sliding door **504** moves up along the guiderails **512**.
24. At a certain point, locking teeth **513** of the swivel lock mechanism **508** engage with the locking pin **514** due to the pressure from a spring mechanism and movements of the console sliding door **504** and counterweight **509** are stopped.
25. Door home sensor **516** registers closing of the door and light curtains **515** are disengaged.
26. Loader's magnetic head **300** moves away from the locked swivel lock mechanism **508** and the parcel tray **100** is pulled out of the internal console **500**.
27. Measurement curtains **503** register that the parcel has been removed.
28. Registry software finds an optimal location for the empty parcel tray **100** in the shelf columns
29. Home sensor **208** registers retrieval of the magnetic head **300**.
30. Mast drive motor **401** engages with the drive belt and moves the mast **400** horizontally in front of the designated pair of shelf supports **602***a*.
31. Simultaneously the lift drive motor **409** engages with the pulley system **410** and drive belts **411** and moves the loader **200** vertically in front of the designated parcel location between the pair of shelf supports **602***a* (i.e. in front of the target shelf) (counterweights **412** move vertically in the opposite direction).
32. Loader's electric motor **203** engages with the drive belt system **205** and moves the magnetic head **300** horizontally with the empty parcel tray **100** in the shelf column **602***b* between the pair of shelf supports **602***a* (i.e. to the shelf nr XX).
33. At the end position of the magnetic head **300** the loader's electric motor **203** is disengaged, electromagnet **301** is disengaged and pushers **302** push the empty parcel tray **100** off from the magnetic head **300**.
34. Sensor **304** registers unattachment of the parcel tray **100**.
35. Loader's electric motor **203** is reversed and moves the magnetic head **300** without the parcel tray **100** out from the shelf column **602***b* in between the pair of shelf supports **602***a*.
36. Home sensor **208** registers retrieval of the magnetic head **300**.
37. Mast **400** and loader **200** are placed into their parking positions/idle position in front of the internal console **500** and the cycle is completed.
38. Alternatively, if there are multiple parcels **20** on multiple parcel trays **100** associated with the same order number, the process continues automatically from the point 4.

Safety Features of the Terminal in Normal Operation

The safety of the user when operating the parcel terminal is ensured by the combination of mechanics and safety sensors.

In a normal working situation where the mast **400** is being moved horizontally and loader **200** is being mover vertically, user has no access to the moving parts of the terminal, as the console sliding door **504** is closed and mechanically locked by the locking teeth **513** of the swivel lock mechanism **508**. The locked state of the door is verified by the door home sensor **516**.

Door is opened only when a parcel tray **100** is inserted into the internal console **500**. At that point the door home sensor **516** with designated safety class registers the opening of the console sliding door **504** and switched on the light curtains **515** with designated safety class. When a user places his or her hand between the console sliding door **504** and arriving parcel tray **100** the light curtains register the obstruction and immediately stop the movement of the parcel tray **100** and thus the console sliding door **504**. The movement of the parcel tray is continued only once the obstruction from between the light curtains **515** is removed.

The door closes on its own when the parcel tray **100** is removed from the internal console **500** due to the force from the counterweight **509** but the closing process is controlled additionally by the movement of the parcel tray **100**. The light curtains **515** remain switched on as long as the door home sensor **516** has no "door closed" signal. When a user places his or her hand between the support structure **501** and console sliding door **504** the light curtains register the obstruction and immediately stop the movement of the parcel tray **100** and thus the console sliding door **504**. The movement of the parcel tray is continued only once the obstruction from between the light curtains **515** is removed.

Safety Features in Special Cases

Safety of the user is considered in various special situations as illustrated below.

a) Signal from the door home sensor **516** is lost.

Light curtains **515** remain activated and stop any mechanical movements of the parcel terminal while being obstructed. Parcel terminal registers an error as a parcel tray is not in the internal console **500** while the door home sensor **516** has no signal.

b) Light curtains **515** fail to detect an obstruction when door is being closed.

The counterweight of the door mechanism is chosen such that even if the user places his or her hand between the console sliding door **504** and support structure **501** the force from the door is low enough so the user can hold back the

door with the hand. Furthermore, the door closes in an upward movement, thus not acting as a guillotine.

c) Drive belt **510** of the console sliding door **504** mechanism breaks.

Console sliding door **504** moves down and opens, door home sensor **516** activates the light curtains **515** and these stop any further mechanical movements of the parcel terminal while being obstructed. Parcel terminal registers an error as a parcel tray is not in the internal console **500** while the door home sensor **516** has no signal.

d) User holds down the console sliding door **504** while parcel tray **100** is removed from the internal console.

Light curtains **515** detect an obstruction and stop any mechanical movements of the parcel terminal. If curtains fail to detect an obstruction, the console sliding door **504** will close on its own and lock into position once the user has disengaged from the door. If user does not disengage from the door after certain time has passed, parcel terminal registers and error as a parcel tray is not in the internal console **500** while the door home sensor **516** has no signal.

Mast and Lift Movement Synchronization (Synchro-Move)

This operation is described in flow chart of FIG. **17**. In a self-service parcel terminal with one insertion and extraction point the movement speeds of mast **400** and loader **200** lift are maximized within the strength limits of the participating elements in order to provide as fast parcel insertion and extraction as possible. Parcel insertion and extraction speeds are important for customer and courier in order to reduce their waiting times at the terminal. However, the faster the speeds, the more expensive elements are necessary to realize the associated movements.

In known solutions the movement speed of the longer movement axis is faster, and the speed of the shorter axis is slower. This enables to provide fast servicing of customers and enables to reduce required material for one of the axes and thus cost and energy consumption of the machine.

However, the vertical and horizontal travel distances in the parcel terminal continuously vary due to the variation in both the starting position and desired end position (vertical and horizontal co-ordinates) of the mast and the loader. This results in a phenomenon where one of the axes reaches its end position earlier than the other without any gain in the insertion and extraction speed of the parcel and results in unnecessary high stress on that particular axis.

In this disclosure solution is provided where this phenomenon is eliminated due to control logic of the computing device of the terminal. When movement commands from the control logic of the computing device are issued to the mast and lift assembly moving the loader, their starting horizontal and vertical co-ordinates are evaluated against the desired horizontal and vertical co-ordinates. The desired movement distances and travel times are calculated with maximum allowed speeds of the axes. The axis with the longer travel time is now taken as a benchmark and the speed of the other axis is reduced to a level where travel times for both of the axes are equal. Thus the horizontal movement of the mast and the vertical movement of the loader synchronized in a manner that each of them reaches their predetermined destination at the same time.

This operational mode enables to reduce the fatigue loads on the participating components for both axes without reducing the parcel insertion and extraction speed. As a result, the participating components can be designed with lower cost or can have a longer lifetime and service intervals.

Extreme Weight Control (EWC)

In a self-service parcel terminal with one insertion and extraction point the movement speeds of mast **400** and loader **200** lift are maximized within the strength limits of the participating elements in order to provide as fast parcel insertion and extraction as possible. Fast parcel insertion and extraction speeds are important for customer and courier in order to reduce their waiting times at the terminal. However, the possible maximum speeds also depend on the weight of the parcels that are moved inside the machine. Generally, the parcel weights are also subjected to maximization within the strength limits of the participating elements in order to allow for customers to extract or insert as large population of parcels as possible. However, the faster the speeds and heavier the parcels, the more expensive elements are necessary to realize the movements.

In known solutions the allowed parcel weights are limited up to a certain theoretical number and parcels are moved with same speed regardless of their weight. This results in non-optimal speed distribution where light parcels are moved unnecessary slow. In certain embodiments the parcels are weighed during insertion which allows to move them according to their weight. However, the elements to facilitate weighing are expensive and add additional complexity to the terminal. In case parcel weighing is not implemented, the parcel weight restriction is only theoretical, as customers still have a possibility to insert heavier parcels and therefore endanger the machine with high loads.

In the self-service parcel terminal described here, these shortcomings are eliminated by control logic of the computing device of the terminal. When movement commands from the control logic of the computing device are issued to the magnetic head, mast and loader lift, the loads (driving current) on the electrical motors are constantly monitored by the built-in monitoring device of the motors. When the loads reach a certain limit, the speed and acceleration of the motors are adjusted (no longer increased or even reduced) in a manner where the loads are constantly kept under the limit.

This operational mode enables to reduce the fatigue loads on the participating components as heavier parcels are automatically moved with lower speeds. As a result, the participating components can be designed with lower cost or can have a longer lifetime and service intervals. Furthermore, the elements that facilitate movement of the axes are automatically protected against insertion of parcels that are heavier than allowed.

Additionally, the monitoring of the motor loads can be used as driving parameters for the acceleration and speed of the axes, so as all parcels are always moved with maximum allowed motor load. This would enable to greatly increase the insertion and extraction speed of parcels in case they are considerably lighter than the maximum allowed parcel weight.

Example 1 of the Use

User approaches the external console and touches the display to activate it. User scans or enters the order number. Upon receiving the order number, the computerized system causes the following: the mast moves the loader to front of the parcel tray that contains client's goods. The magnetic head of the loader moves against parcel tray's magnetic plate, attached and pulls the parcel tray onto itself. The mast moves the loader to the internal console loading position. Loader pushes the parcel tray into the internal console. The parcel tray interacts with the sliding door opening mecha-

nism. The door is unlocked and opened. The client can retrieve the goods from the parcel tray. Once the goods have been removed or certain time has passed, the loader pulls the parcel tray from the internal console. Consequently, the door slides up and locks into position. The loader and mast store the parcel tray at a designated spot.

Example 2 of the Use

Courier approaches the external console and touches the display to activate it. Courier scans the barcode or enters relevant information via the display. The computerized system causes the following: An empty parcel tray is brought to the internal console. The parcel tray interacts with the sliding door opening mechanism. The door is unlocked and opened. Once the parcel tray reaches the end position in the internal console the light curtains are deactivated, now courier can place a parcel into the parcel tray. The loader retracts the parcel tray from the internal console, door closes and locks. The parcel tray passes through measurement curtains where its height is measured, mast and loader place the parcel into an optimal spot in the machine. The process is repeated until all parcels have been inserted into the machine.

ELEMENT LISTING

10—automated parcel terminal
12—outer shell of the terminal
20—parcel
100—parcel tray
101—tray base
102—metal/steel plate
200—loader
201—main frame
202—guiderails
203—electric motor
204—linear guiderail system
205—drive belt system
206—adjustment screws
207—plates
208—home sensor
209—rollers
210—adjustable plates
300—magnetic head
301—electromagnet
302—pushers
303—housing
304—sensor
400—mast
401—mast drive motor
402—carriage
403—drive belt system
404—upper support rollers
405—lower support rollers
406—bottom plate
407—bottom guide rollers
408—beams
409—lift drive motor
410—drive pulley systems
411—drive belts
412—counterweights
413—homing sensor
414—camera
415—homing sensor
416—top plate
417—groove of the beam
418—counterweight slider
419—vertical guiding groove
420—mast's drive belt
500—internal console
501—support structure
502—guide rails
503—measurement curtains
504—console sliding door
505—horizontal slides
506—vertical slides
507—carriage
508—swivel lock mechanism
509—counterweight
510—L-shaped drive belt loop
511—drive belt pullies
512—guiderails
513—locking teeth
514—locking pin
515—light curtains
516—home sensor
517—counter
518—optical sensors
519—spring mechanism
520—bracket
600—internal structure
601—mast top rail
601*a*—upper mast rail contour
601*b*—lower mast rail contour
602—shelf structure
602*a*—shelf supports
602*b*—shelf column
603—outer frame
604—mast bottom rail
605—support beams
606—external console
606*a*—touch screen
607—sheet metal panels
608—anti-collision bollard

What is claimed is:

1. An automated parcel terminal comprising:
an outer shell and an internal structure;
the outer shell comprising an external console for user identification, communication between the user and the terminal, and for retrieval or deposit of a parcel;
the internal structure comprising:
at least one row of vertical shelf supports to adapt a multitude of parcel trays in between the supports,
a mast moving horizontally along a top rail and a bottom rail and in parallel to the at least one row of shelf supports,
a loader configured to move vertically on the mast and being capable of gripping a parcel tray with or without a parcel via an attachment mechanism, and moving the tray horizontally in a direction perpendicular to the moving direction of the mast, and
an internal console located between two shelf supports within the at least one row of vertical supports;
the internal console comprising:
a support structure onto which a pair of parcel tray guiderails are attached,
a console sliding door,
light curtains, and
a mechanism to operate the sliding door,
wherein the mechanism to operate the sliding door comprises a horizontal slide supporting a swivel lock

mechanism, a vertical slide comprising a counterweight, and an L-shaped drive belt loop connecting the swivel lock mechanism, the counterweight, and the console sliding door such that the door moves upward to a closed position and downward to an open position via front-to-back movement of the swivel lock mechanism on the horizontal slide, and wherein the door sliding downward to the open position is initiated when a parcel tray is pushed by the loader on to an end position on the guiderails, and the door sliding upward to the closed position is initiated when the parcel tray is pulled off by the loader from the guiderails and the counterweight moves the swivel lock mechanism to end of the horizontal slide where locking teeth engage with a locking pin so as to make it impossible to open the door from outside.

2. The automated parcel terminal of claim **1**, wherein the attachment mechanism of the loader comprises a horizontally moving magnetic head on the loader and the parcel trays having a metal portion for an electromagnet of the magnetic head to attach.

3. The automated parcel terminal of claim **1**, wherein the mast comprises a mast motor on top of a mast structure configured to move the mast horizontally in the parcel terminal and a lift assembly configured to move the loader vertically along the mast, wherein the lift assembly comprises:

two vertical hollow beams both of which have vertical guiding grooves for adapting rollers of the loader to movably attach the loader in between the beams;

a lift drive motor and a drive pulley system on top of the mast structure; and

two open ended drive belts running partially inside the beams and having one end of each belt connected to the loader and the other end of each belt connected to a counterweight and the counterweight moving vertically inside the hollow beam and being guided along grooves on the inner surface of the beam.

4. The automated parcel terminal of claim **3**, wherein the hollow beams have a flat U-shape cross section and the counterweight moves vertically in the inner space of the U-shape.

5. The automated parcel terminal of claim **3**, wherein the counterweight has a slider fitting into the groove for guiding the movement of the counterweight.

6. A mechanism to open and close a sliding door of an internal console of an automated parcel terminal, wherein the mechanism comprises:

an L-shaped continuous drive belt loop having a horizontal part and a vertical part, the drive belt looping around pulleys at both ends of its L-shaped form;

a carriage supporting a swivel lock mechanism connected to the horizontal part of the drive belt,

a counterweight connected to a back side of the vertical part of the drive belt loop and the sliding door connected to a front side of the vertical part of the drive belt loop,

wherein the carriage is configured to move forward when a parcel tray is inserted into the internal console causing the drive belt loop to move in a direction pulling the sliding door downward into an open position, and the carriage further being configured to move backward when the parcel tray is removed from the internal console causing the drive belt to move in a direction pulling the sliding door upward into a closed position and the swivel lock to move to a locked position preventing opening of the door from outside.

7. A method to operate a sliding door of a self-service parcel terminal, wherein the method comprises:

opening the sliding door when:

upon a loader inserting a parcel tray onto tray guiderails in an internal console of the terminal, an end of the parcel tray engages with a swivel lock mechanism supported on a carriage on a horizontal slide in the internal console causing the swivel lock mechanism to disengage from a locking pin, and

upon the loader pushing the tray further into the internal console along the tray guiderails the carriage connected to a counterweight and to the sliding door moves forward along the horizontal slide and causes the counterweight to move upward along a vertical slide and the sliding door moves down in an open position;

and closing the sliding door when:

the loader pulling the parcel tray back from the internal console of the terminal, the carriage connected to the counterweight and to the sliding door, moves backward along the horizontal slide and causes the counterweight to move downward along the vertical slide and the sliding door moves upward in a closed position; and

locking the door when:

the end of the parcel tray disengages with the swivel lock mechanism on the horizontal slide in the console causing the swivel lock mechanism to engage with the locking pin locking the door in closed position.

8. The method of claim **7**, wherein the carriage, the counterweight and the sliding door are connected via an L-shaped drive belt loop.

9. The method of claim **8**, wherein the drive belt loop is arranged in a L-shaped form via pullies at each end of the horizontal and vertical slides.

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